Sky and TELESCOPE

Observing on Fritz Peak

In This Issue:

Vol. XVII, No. 4

FEBRUARY, 1958

50 cents

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A Survey of Astronautical Periodicals

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Sky and TELESCOPE

CHARLES A. FEDERER, JR., *Editor*
JOSEPH ASHBROOK, *Technical Editor*

Vol. XVII, No. 4 FEBRUARY, 1958

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COVER: On Fritz Peak, Colorado, these instruments of the Central Radio Propagation Laboratory, National Bureau of Standards, scan the heavens to measure the intensity of the airglow, the zodiacal light, the gegenschein, and other features of the night sky. Physicist L. R. Megill stands beside the housing of a newly developed birefringent-filter photometer, and an earlier photometer is contained in the shelter at the right. On the skyline to the lower left is the Continental Divide of the Colorado Rockies. National Bureau of Standards photograph. (See adjoining column and page 164.)

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FEATURE PICTURE: The spiral galaxy Messier 83, NGC 5236, photographed with the Radcliffe Observatory 74-inch reflector on August 2, 1956. This is a reproduction of Print 18 of the Cape Photographic Atlas of Southern Galaxies, the plates for which have been taken by members of the staff of the Royal Observatory at the Cape of Good Hope, Union of South Africa. 172

SKY AND TELESCOPE is published monthly by Sky Publishing Corporation, Harvard College Observatory, 60 Garden St., Cambridge 38, Mass. Second-class mail privileges authorized at Boston, Mass.

Subscription: $5.00 per year in the United States and possessions; $9.00 for two years; $13.00 for three years. Add $1.00 per year for Canada, Mexico, and all countries of the Pan American Postal Union, making the total subscription $6.00 for one year; $11.00 for two years; $16.00 for three years. Add $2.00 per year for all other foreign countries, making the total subscription $7.00 for one year; $13.00 for two years; $19.00 for three years. Canadian and foreign remittances should be made in United States currency. Single copy 50 cents. Back numbers, as available, 50 cents each.

All notices of change of address must be sent one month in advance and accompanied by old and new addresses. When sending your renewal order, or writing in regard to your subscription, your current mailing address must be given. Please return our bill form with your renewal payment. Circulation staff: Nancy R. Bolton, manager; Caroline Nason; Helen B. Sniegiecki; Stacia Strong.

Editorial and advertising offices: Harvard College Observatory, Cambridge 38, Mass. Advertising manager, Henry M. Corrado. Advertising rates are listed in STANDARD RATE AND DATA SERVICE, or sent upon request.

Unsolicited articles and pictures are welcome, bearing adequate return postage, but we cannot guarantee prompt editorial attention, nor are we responsible for the return of unsolicited material. Editorial assistants: Virginia K. Cox; Elizabeth C. Merrylees; William E. Shawcross. The principal articles are indexed in THE READERS' GUIDE TO PERIODICAL LITERATURE.

Night-Sky Observatory

HIGH in the Colorado Rockies is a mountain observing station maintained by the Central Radio Propagation Laboratory, National Bureau of Standards, to study the light of the night sky. There observations are made of the zodiacal light and the gegenschein, and the airglow or self-light of the atmosphere.

A 25-mile drive from Boulder, Colorado, along an all-weather highway takes observers to the foot of Fritz Peak, which is near the town of Rollinsville, east of the Continental Divide. In good weather, one can drive part way up to the summit, but during winter an observer may need snowshoes for a quarter of a mile.

This month's front-cover photograph is of the extreme top of Fritz Peak, and shows the photometer used by Franklin E. Roach and his associates for some of the observations mentioned by him and Pauline M. Jamnick on page 164. The semicylindrical instrument cover has been turned over on its pivots to expose the photometer, which employs birefringent filters to measure the airglow brightness at several selected wave lengths. The instrument shelter at the right houses an older-type photometer that Dr. Roach formerly used at Cactus Peak, California.

This observing location was chosen because its elevation is about 9,000 feet, it has all-year accessibility, commercial electricity is available, and it is within an hour's driving time from the laboratory headquarters in Boulder. The site is leased from the owner of Severance Lodge, immediately adjacent to the mountain. The location is not isolated, being only 15 miles from Central City (where every summer there is good opera and theater) and 10 miles from the Moffatt Tunnel.

All the equipment and building materials for the station were hauled up the mountain on a sled by winch and electric motor. The laboratory building there is of metal, 20 by 24 feet, and contains the recording equipment, two bunks, and a small kitchen. Rain is collected from the roof or snow is melted for water. No one lives permanently at the laboratory, but the station is attended daily – usually there are two observers on duty.

Some years ago, when Dr. Roach selected this observing site, the mountain was called Little Dutch Peak and another nearby was Big Dutch Peak. Before World War I, local people had called them Fritz and Hans, after the Katzenjammer Kids of comic-strip fame. Neighbors were rather surprised when the Bureau of Standards scientists reverted to the old name for their observing station. The official explanation is that the mountain has been renamed in honor of Prof. Hermann Fritz, famous for his auroral investigations during the first International Polar Year (1882-83).

In the spring of the year, to observers in mid-northern latitudes the zodiacal light appears as a cone sloping southward from the western horizon after sunset. Reproduced from "Astronomie," by Rudaux and de Vaucouleurs, published by Librairie Larousse, Paris, 1948.

THE SKY AND EYE

FRANKLIN E. ROACH
and PAULINE M. JAMNICK
Boulder Laboratories
National Bureau of Standards

THE FIRST TELESCOPE was the eye. In ancient times it was used to map the constellations, to follow the wandering planets, and to sort the stars into a rough magnitude scale. After the invention of the optical telescope, the eye continued to be a primary research tool in the study of planetary, lunar, and solar details, and of variable stars and double stars. Early observations of the spectra of the sun and stars were visual. However, the rise of photography, and later the photoelectric cell, rapidly relegated the eye to a secondary role, and today relatively little observatory research is by visual methods.

Why, then, should we concern ourselves with the human eye as an observing tool? For a number of years the authors have been making systematic photoelectric studies of the airglow (the light of the night sky), the occasional auroras that occur at low latitudes, the zodiacal light, and the gegenschein. Visual observations of the sky are made chiefly to note the presence of clouds, but incidentally to examine directly the phenomena that are being recorded by our photometers. Thus we have become interested in matters such as the dark adaptation of the eye, its visual threshold, and its color threshold. In particular, the question has always arisen: Why is the gegenschein so very difficult to detect visually? We shall try to answer this and some similar questions.

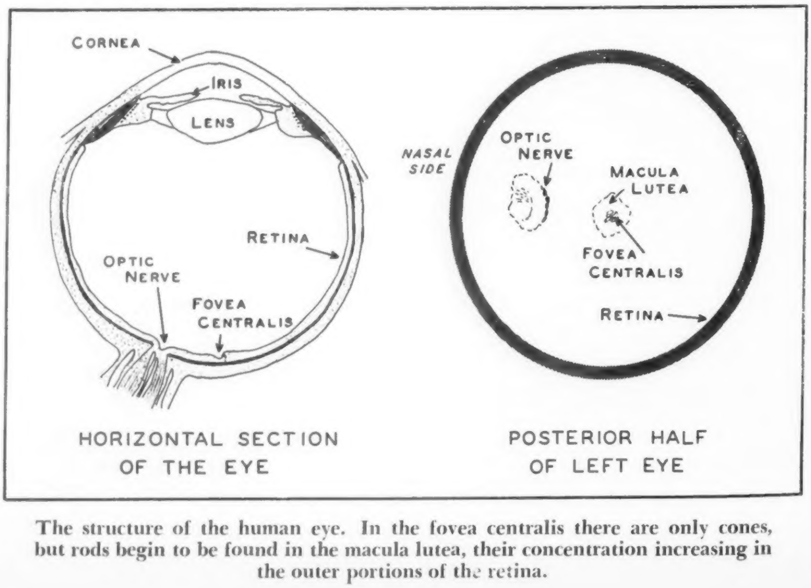
A study of the anatomy and physiology of the eye should excite admiration. Here is an instrument beautifully adapted to its human need. Those fortunate individuals who have good eyesight can find the universe of form, light, shadow, and color a source of daily enrichment. But as a scientific instrument, the eye has certain very definite limitations, which must be understood before visual observations can be critically interpreted.

The lens of the eye focuses an inverted image of the object on the retina. The quality of the image is best within about one or two degrees of the optical axis. Considering the retina as a wide-angle receiver, we may say that it varies radially in resolution (visual acuity), threshold response, and color response. Similarly, in the case of a large-field Schmidt telescope, from the center of the field to the edges there are changes in image quality, limiting magnitude, and color equation.

For the eye, a given impression is the sum of light stimuli from various parts of the retina, especially in the case of extended objects like the gegenschein. As the light strikes each element of the retina, separate nerve impulses travel to the brain, which then combines the contributions from all parts of the retina into one complete impression, much as the numerous dots of a halftone illustration form a single picture.

There are two types of sensitive light receivers in the retina. To early anatomists, their appearance under the microscope suggested the names of *rods* and *cones*. Actually, the fundamental distinction between rods and cones seems based on their chemistry. The rods contain a chemical substance, popularly known as visual purple, which is not present in the cones. When the retina is in darkness, the rods accumulate visual purple, leading to an increase in sensitivity (dark adaptation). Thus, at extremely low light levels, vision of the dark-adapted eye is almost exclusively by means of the rods.

Over the entire retina there are an estimated seven million cones and 130 mil-



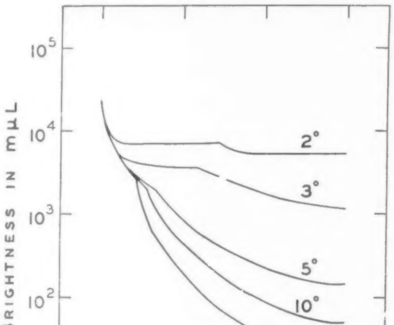
The structure of the human eye. In the fovea centralis there are only cones, but rods begin to be found in the macula lutea, their concentration increasing in the outer portions of the retina.

lion rods. On the optical axis of the eye there is a small region called the *fovea centralis*, which subtends an angle of one to two degrees. This region is populated only by cones, and here vision is very distinct at high light levels, for each cone is connected to the brain by a separate nerve.

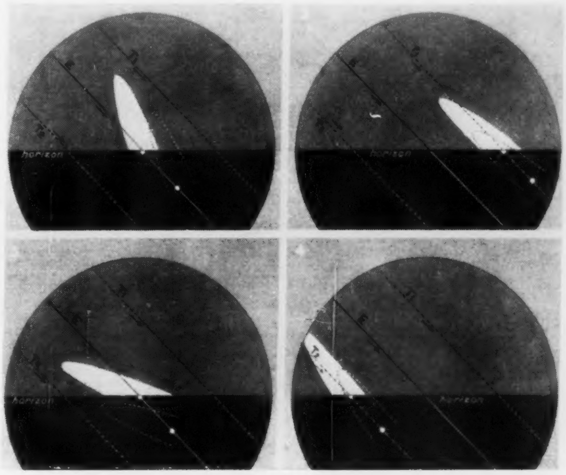
Around this fovea is a yellowish region known as the *macula lutea* or yellow spot. It covers about four by 12 degrees of the field of view. In the yellow spot the rods begin to appear, and become steadily more numerous relative to the cones, going outward from the center to the periphery of the retina. At the extreme edge – approximately 120 degrees from the optical axis – the concentration of cones increases slightly.

The eye has an amazing adaptability to brightness levels over a range of about one millionfold. Expansion and contraction of the iris control the amount of light entering the eye. The extreme diameters of the pupil are, however, about three and eight millimeters, giving an area ratio of only seven to one.

The larger part of the accommodation to darkness takes time; at extremely low light levels, there is still some gain in sensitivity even after one hour of complete darkness. Initial dark adaptation takes place in five to 10 minutes, during which there is an increase in sensitivity (a decrease in visual threshold) of about 10 times. Then there follows a second phase of dark adaptation due to the rods; for large fields these can give an additional hundredfold increase in sensitivity after 30 minutes in the dark. After half an hour of dark adaptation under laboratory conditions, a person can detect by peripheral (averted) vision a circle 20 degrees in diameter whose brightness is only four milli-microlamberts (4 mμL). This is only about five billionths (5×10^{-9}) the average brightness of a clear daytime sky.



As the human eye rests in complete darkness, the threshold brightness (that of an object that is just visible) decreases as shown by these curves. The threshold is lower for subjects of larger angular extent, and continues to fall for well over 30 minutes after dark adaptation begins. These curves are for centrally fixated fields; if peripheral (averted) vision is used, significantly fainter illumination can be detected by the eye. National Bureau of Standards chart.



These drawings from "Astronomie," by Rudaux and de Vaucouleurs, show changes in evening visibility of the zodiacal light in middle northern latitudes. The most favorable position is in March (upper left), when the ecliptic stands most nearly vertical to the western horizon. June (upper right) and December (lower right) are less well suited for observation. Least favorable is September (lower left). In each case, the sun is indicated by a white spot, first just at sunset and then considerably later.

THRESHOLDS OF THE HUMAN EYE

Type of Vision	*Size of Field*	*Threshold (mμL)*
Color	2°	4,000
Color (distorted)	2°	1,300
Foveal (cones)	1°	1,800
Centrally fixated	20°	17
Peripheral (rods)	8°	4

Color is easy for the spectroscopist to specify; the wave length of a spectrum feature such as the D-lines of sodium describes its "color." On the other hand, the visual observer of colors is working in a complex, subjective field. Of particular interest to astronomers is color perception at low light levels. Laboratory tests show that the color of an extended object can be perceived only if it is at least 100 times brighter than the absolute visual threshold.

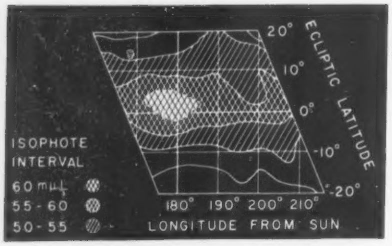
Thus there is a considerable "twilight zone" in which the eye is able to detect shades of intensity but not color. (At night all cats are gray!) Near the color threshold there are distortions in color perception; one of these is the well-known Purkinje effect, whereby with decreasing brightness red is the first to disappear.

Let us make use of these laboratory results in interpreting visual observations of the zodiacal light, which is the large, faint conical glow seen along the ecliptic, in the western sky after sunset or in the east before dawn. The principal problem in observing the zodiacal light is distinguishing it from the twilight, dawn, or Milky Way. It has a brightness of 27,000 mμL at a distance of five degrees from the sun's edge, 470 at 30 degrees, and 100 at 60 degrees. At five degrees from the sun, the zodiacal light is as intense as a bright aurora, but it cannot be seen from the earth's surface either in full day or during twilight, because of the still brighter scattered sunlight. Except at times of total solar eclipses or observations from extremely high altitudes, we cannot see the zodiacal light closer than about 20 or 25 degrees from the sun, just after twilight or before dawn (see *Sky and Telescope* for March, 1954, page 144). In the absence of city lights and moonlight, the zodiacal band can be followed nearly across the sky.

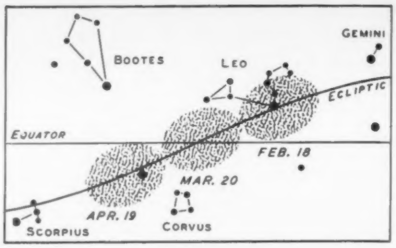
The best seasons for observing the zodiacal light are when it is clear of the Milky Way and when the ecliptic has its maximum inclination to the horizon. At latitude 40° north, the optimum conditions for viewing the evening zodiacal light come in February and March, and for the morning zodiacal light in September and October. In August the evening zodiacal light is well away from the Milky Way, but then is inclined only about 30 degrees to the horizon. Likewise, in April the morning zodiacal light is at maximum distance from the Milky Way, but the small angle it makes with the horizon is unfavorable.

Some observers are able to trace the entire zodiacal band to a brightening opposite the sun in the sky, but this gegenschein or counterglow is a difficult object to observe. It is an extended, slightly oval patch perhaps 20 by 30 degrees in size. Exact dimensions cannot be given, since it merges gradually into its surroundings. The difficulty of detecting it is evident from the fact that many trained observers have not been sure of its reality even when they knew its location in the sky. It is best seen by averted rather than direct vision.

The gegenschein has a central intensity of about 60 mμL, which would be readily recognizable by a dark-adapted eye, if the background sky were perfectly black. But the actual gegenschein has to compete with a background of starlight, airglow, and the general zodiacal band, so that it



The chart at the left contains contours of equal brightness in the gegenschein, from one night's observations at Fritz Peak, Colorado. Although well-defined photometrically, the counterglow is difficult to see because it merges with the zodiacal band and the general light of the night sky. Its positions on new-moon dates this spring are charted at the right.



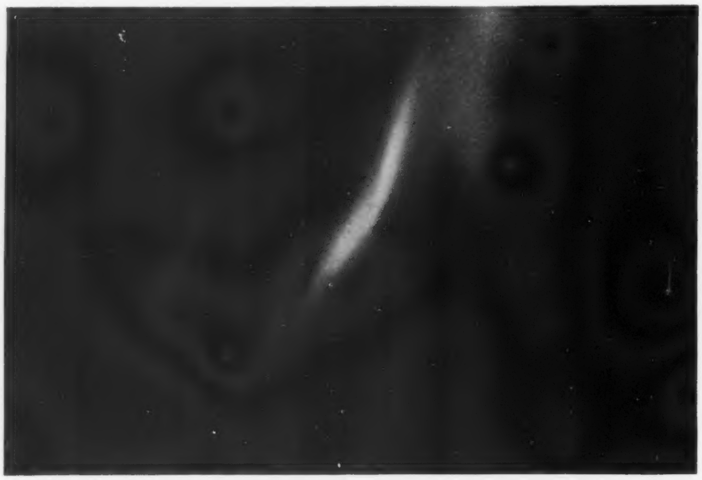
is only about 15-per-cent brighter than its surroundings. In other words, under the best conditions its brightness is about 15 mμL superimposed on a background of about 100 mμL.

This dim glow moves along the ecliptic, six months ahead of (or behind) the sun. It crosses the Milky Way during the summer and winter months, and is more than 40 degrees from the Milky Way from February 6th to May 3rd, and from August 9th to November 4th. The gegenschein is farthest from the Milky Way on March 16th and September 24th. Thus, the best times for observing it are on moonless nights near the equinoxes.

The gegenschein is just below the threshold curve for a centrally fixated field, but is comfortably above the threshold curve for averted vision. Hence the observer should dark adapt his eyes for 20 to 30 minutes, and use averted vision. Near midnight the counterglow is highest in the sky. Under the conditions mentioned, it should be visible to a person with normal eyes. Observers in the tropics have a distinct advantage, for the gegenschein comes to its midnight meridian crossing near the zenith, where airglow and scattered light are both at a minimum.

The Milky Way is seen with no difficulty if the observer is away from city lights on a clear, moonless night. Star counts indicate that on the average there are about five times as many stars per unit area in the Milky Way as at its poles. Thus, if the luminosity of the night sky were due mainly to starlight, the Milky Way should stand out very strikingly. In reality, it does not have a contrast with its surroundings even approaching a ratio of five to one. The contrast is obviously much reduced by the amount of airglow and zodiacal light in the sky background.

During the past year an unusual number of bright displays of the aurora have attracted the attention of amateur astronomers. Visual observations have been widely used for statistical studies of auroras, and for mapping the geographical extent of individual auroral storms. During the current International Geophysical Year, many observers are co-operating in making systematic records of auroras, as described in *Sky and Telescope* for May, 1957, page 327.



One of the brightest displays in recent times, the aurora of September 18-19, 1941, was observed in many parts of the United States. At Farmingdale, New York, Fred Schmidt took this 30-second exposure of the lower end of a rayed band.

Since the brighter auroras are well above the visual threshold, it is possible to detect much structural detail and to watch its variation with time — information that can be very valuable.

Visual observers make rough estimates of auroral intensity on an international brightness coefficient (IBC) scale. There are four classes: I, about as bright as the Milky Way; II, brightness of the order of a thin moonlit cirrus cloud; III, brightness of a moonlit cumulus cloud; IV, total brightness approximately equal to moonlight.

This semiquantitative IBC scale is quite crude and decidedly subjective, but recently efforts have been made to define the scale in absolute units. From such studies, it is found that color is distinguishable only for brighter auroras (classes II+, III, IV). If direct vision is used, structural detail as small as one degree should be recognizable only for auroras as bright as III and IV, while larger structure of the order of five degrees across should be discernible for fainter auroras (I and II). If averted vision is used, however, it may be possible to detect detail as small as one degree for faint auroras.

Twilight is the most easily observable of all the phenomena we are discussing. During the interval between sunset and the end of evening twilight, the sun sinks 18 degrees below the horizon. At dawn the reverse occurs. In the tropics this

The Milky Way band stretches completely around the heavens, and it appears noticeably brighter than the sky on either side of it. Here we see, in a Harvard photograph on an ordinary blue-sensitive emulsion, the region of the southern Milky Way that contains the Southern Cross (upper left part), with the dark Coalsack next to it.

requires about an hour, so that "dawn comes up like thunder." In middle latitudes about 1½ hours are needed. During this 90 minutes striking changes occur. If there are clouds, this is the time of rapid and dramatic color effects. When clouds are absent, the changes are less spectacular but more predictable. The zenith brightness decreases some millions of times from sunset to the end of twilight. When the sun is nine degrees below the horizon (about 45 minutes after sundown in middle latitudes), the zenith intensity is at the color threshold, a fact which can be easily verified on a moonless night away from city lights. However, color will still be discernible near the western horizon.

The Dutch astronomer, M. Minnaert, has written a book, *The Nature of Light and Colour in the Open Air* (conveniently available in an English translation printed by Dover Publications in 1954), which contains a fascinating collection of descriptions of natural visible phenomena. His account of the sequence of events during twilight should be read by all who wish a full appreciation of this drama. It can be enjoyed by the night observer, for whom the evening twilight is a waiting period: Rotation of the earth and accumulation of visual purple in the rods of his retina during dark adaptation bring about favorable conditions for the observation of elusive, extended objects in the night sky.

Another component of the light of the night sky is the airglow – radiation characterized by a spectrum emission line of 5577 angstroms wave length. Photo-

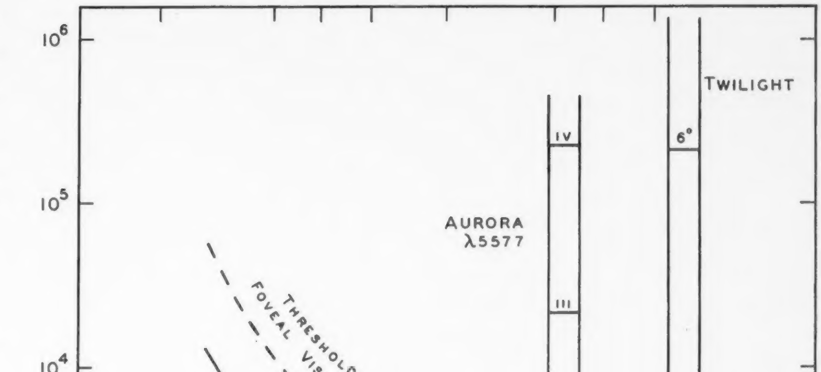
BRIGHTNESS OF SOME ASTRONOMICAL PHENOMENA

In milli-microlamberts (mμL)

Object	*Max.*	*Mean*	*Min.*
Gegenschein (above surroundings)	—	15	—
Gegenschein (absolute)	—	60	—
Zodiacal light	500	—	100
Milky Way	170	60	40
Airglow (5577 angstroms)	440	50	20
Aurora — IBC I		220	
Aurora — IBC II		2,200	
Aurora — IBC III		22,000	
Aurora — IBC IV		220,000	
Twilight (sky at the zenith)			
Sun on horizon		5×10^8	
Sun 6° below horizon		2×10^5	
Sun 9° below horizon		5,000	
Sun 12° below horizon		400	
Sun 15° below horizon		140	

Data from the table above have been plotted in the chart at the right, where direct comparison can be made with curves showing the brightness threshold and color perception of the human eye. Colors cannot be distinguished below the horizontal color-threshold line. In the zodiacal-light box, the degrees (30° and 60°) indicate distance from the sun. The hatching has been used only to delineate clearly the three faintest phenomena.

A striking phenomenon during evening twilight is the earth-shadow rising in the east. The line bounding the directly illuminated region of the atmosphere is recorded in this photograph by Arthur A. Hoag, looking eastward from the grounds of the U. S. Naval Observatory's station at Flagstaff, Arizona. It was taken November 16, 1956, at the time of local sunset, just when the shadow line on Mt. Elden (at the left in the picture) was at the same elevation as that of the station. The long dark mesa extending from below Mt. Elden to the right is Mars Hill, where Lowell Observatory is located; part of the town of Flagstaff is seen at the extreme right. U. S. Navy photograph.

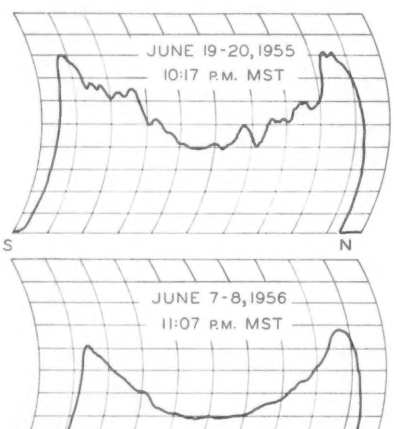


Here on the summit of Fritz Peak are the instruments also seen closeup on the front cover. At the right, in a rock saddle that affords some protection from the strong Rocky Mountain winds, is the metal laboratory with living quarters. Out of sight in this picture are the mountings for an all-sky camera, a patrol spectrograph, and a zenith-monitoring airglow photometer. In spite of its rugged character, this mountain location is accessible throughout the year, as described on page 163. This site is almost due north of the airglow station at Sacramento Peak Observatory, Sunspot, New Mexico. National Bureau of Standards photo.

metrically, the bright airglow overlaps the faint aurora in intensity. Too faint to show any color, it should be visually detectable in patches of the order of 10 degrees in size. It is over twice as bright near the horizon as at the zenith, and this general increase of intensity toward the horizon is definitely apparent to the dark-adapted eye.

At Fritz Peak, Colorado, we occasionally see structural detail in the form of moving wisps 10 to 15 degrees across. Examination of the photoelectric records on the same nights gives evidence of a localized structure which varies in position with time. Such airglow structure occurs at Fritz Peak primarily during the summer.

The front-cover photograph shows at the left a newly developed photometer which employs birefringent filters to measure the airglow intensity in the green light of oxygen (5577 angstroms), red oxygen light (6300), and the yellow D lines of sodium radiation (5893). As seen in the picture, the top of the instrument shelter pivots to expose the entire horizon so the photometer can rapidly scan the sky. Only 3½ minutes are required for a survey consisting of five sweeps around the heavens, at altitudes of 10, 15, 20, 30, and 50 degrees above the horizon, and a "look" at the zenith, while the sky brightness is pen recorded on a paper tape.



Two photoelectric recordings of the night airglow, scanned from the north horizon to the south horizon. The zenith is at about the middle of each tracing. The steady increase of intensity from the zenith to the horizon shown by the lower record is characteristic of the usually prevailing night-sky condition. On rare occasions, however, the airglow has a structure of patchy detail, as in the upper record; it is then sometimes possible to detect airglow details visually.

The closed shelter at the right in the cover picture (also seen in the picture on this page) contains an older photometer comprising four individual telescopes on a single mounting. One telescope is used as a control while the other three evaluate the "contamination" of the light of the night sky from integrated starlight and the zodiacal light.

Since bright airglow and faint aurora (IBC I) have the same absolute brightness at 5577 angstroms, how can they be distinguished? There is no clear-cut answer. Various spectroscopic observers have suggested criteria, such as the enhancement of the red line of oxygen (6300 angstroms) if the phenomenon is an aurora. In any case, the visual observer cannot distinguish between the two.

A practical observing program may be suggested for sky watchers who wish to explore this enchanting world of form and color. To avoid a special dark-adaptation period, at sunset find a comfortable spot with a good horizon and let the eyes slowly dark adapt during the exciting twilight time. Coming up in the east is the dusky shadow of the earth. Note the final loss of color in the zenith during the first hour. By the end of twilight, the zodiacal light may be seen along the western ecliptic, and you will easily detect the Milky Way (unless it is skirting the horizon).

Look to the north (if you live in the Northern Hemisphere) to see if there is any outstanding auroral activity. Look southward to see if you can detect the increase of airglow brightness toward the horizon. Perhaps you will be able to discover some airglow structure under favorable conditions. Near midnight, after the eyes are quite thoroughly dark adapted, look for the gegenschein, but by averted rather than direct vision. During the second half of the night, the program occurs in the reverse order, mostly in the east. The panorama of events that unfolds during such a vigil is most fascinating. And the show is a bargain – it's free!

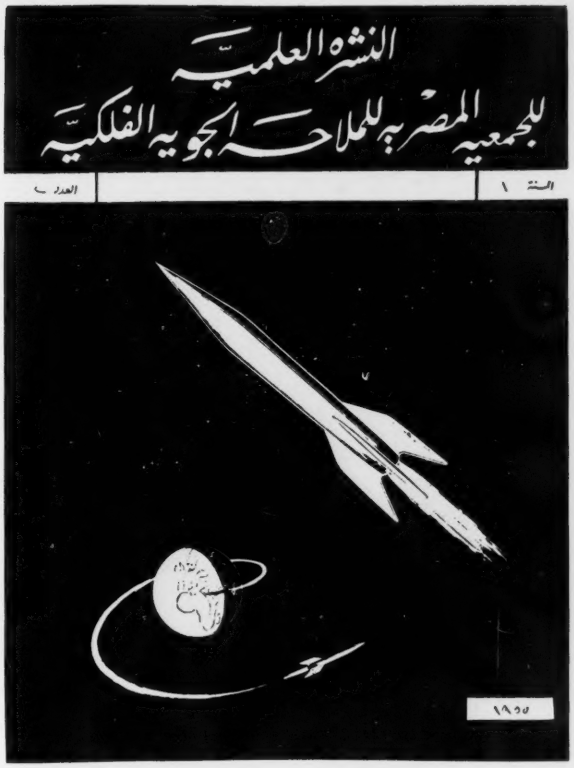
PROJECT STRATOSCOPE REPORT WINS AAAS PRIZE

The Newcomb Cleveland prize of $1,000 is awarded for an outstanding paper presented at the annual meeting of the American Association for the Advancement of Science. The December, 1957, meeting was held at Indianapolis, Indiana, where Section D (Astronomy) of the AAAS convened jointly with the American Astronomical Society.

Selected for the prize was paper No. 29 of the astronomical program, entitled "Solar Photographs from 80,000 Feet," by M. Schwarzschild, J. B. Rogerson, Jr., and J. W. Evans, Princeton University Observatory and Sacramento Peak Observatory. Their work, known as Project Stratoscope, was described by Dr. Rogerson in the January issue of *Sky and Telescope*, page 112.

A Survey of Astronautical Periodicals

FREDERICK I. ORDWAY, III
General Astronautics Corporation



The front cover of the second issue of the Egyptian Astronautical Society's magazine is reproduced here. A literal translation of the title reads, "Scientific Publication of the Egyptian Society for Astronomical Aerial Navigation."

RUSSIAN launchings of Sputniks and successful American firings of Farside rockets to 4,000-mile altitudes have greatly widened the demand for astronautical periodicals and books. Many persons desire fuller information than newspaper accounts of the fast-moving developments in rocketry which are leading to space travel.

A large number of astronautical societies publish their own journals. There is an increasingly important trade and technical periodical literature for specialists. And many other scientific and engineering magazines occasionally carry articles relating to spaceflight. We shall briefly survey the leading periodicals, arranged by countries, that are devoted primarily to rocketry and astronautics.

INTERNATIONAL

All of the important rocket and astronautical societies scattered around the globe now adhere to the International Astronautical Federation (IAF), whose headquarters are in Switzerland. The IAF has an internal bulletin, and also publishes the outstanding *Astronautica Acta*. This technical quarterly contains articles in English, French and German, each accompanied by abstracts in all three languages. An issue runs to about 100 pages. Subscriptions, at $8.60 a year, can be obtained from Springer-Verlag, Mölkerbastei 5, Vienna 1, Austria.

UNITED STATES

The American Rocket Society has been a major source of astronautical literature since 1930, when the ARS (until 1934 the American Interplanetary Society) published its first *Bulletin*, which appeared sometimes monthly and sometimes bimonthly. In 1932 a printed format was introduced and the name was changed to *Astronautics*. During the late thirties the magazine grew more professional. With the 61st issue, in March, 1945, the publication was retitled *Journal* of the American Rocket Society, and in January-February, 1954, the present name, *Jet Propulsion*, was adopted.

A monthly since January, 1955, *Jet Propulsion* is now devoted solely to technical papers. News items, articles of a more popular character, and reviews appear in a new ARS periodical, *Astronautics*, which began with Vol. 2 to distinguish it from the older serial of the same name. With the emergence of the new *Astronautics*, ARS sectional magazines, such as *American Rocket News* and *Missile Away*, have been discontinued.

Jet Propulsion and *Astronautics* are obtainable from the American Rocket Society, 500 Fifth Ave., New York 36, N. Y., at $12.50 and $9.00 per year, respectively. Membership in the society, which includes both magazines, costs $15.00 a year.

A number of other societies, local in nature, have been formed in this country, but only a few of them remain active. The most important current publication by such a group is *Space Journal*, of the Rocket City Astronomical Society at Huntsville, Alabama. Its first number, in the summer of 1957, had an editorial content about equally divided between astronautics and astronomy. A quarterly, *Space Journal* may be secured for $2.25 a year from the society, Box 82, Huntsville, Ala.

The American Astronautical Society, 516 Fifth Ave., New York 36, N. Y., puts out the *Journal of Astronautics*, a quarterly costing $5.00 per annum. The Reaction Research Society publishes *RRS News*, and small bulletins are issued by the Boise (Idaho) Rocket Society, the Philadelphia Astronautical Society, and the Pacific Rocket Society. Most of these smaller rocket and astronautical groups are banded together in the American Astronautical Federation, now mainly inactive.

Several defunct magazines merit mention. The Cleveland Rocket Society, founded in 1933, published four issues of *Space*. Periodicals were printed by the California Rocket Society, the American Institute for Rocket Research, the Westchester (New York) Rocket Society, and the Massachusetts Institute of Technology Rocket Research Society. The Glendale (California) Rocket Society published a *Bulletin*, and later *Astro-Jet*. For a number of years *Rocketscience* was the organ of the Detroit Rocket Society, and the *Journal of Space Flight* by the Chicago Rocket Society was well received until the group disbanded about two years ago.

Aside from society publications, there are a number of important trade magazines dealing with rockets, missiles, astronautics, and aviation. *Missiles and Rockets* is a monthly available for $8.00 a year from American Aviation Publications, 1001 Vermont Ave. N. W., Washington 5, D. C. *Missile Engineering* is a quarterly which reprints missile articles from *Aviation Week*. Both are published by McGraw-Hill Book Co., 330 W. 42nd St., New York 36, N. Y.; subscriptions are $3.00 and $7.00 annually, respectively. Also important is the monthly *Aviation Age*, $10.00 a year, from Conover-Mast Publications, 205 E. 12nd St., New York 17, N. Y.

GREAT BRITAIN

One of the world's oldest astronautical organizations is the British Interplanetary Society (BIS), founded in October, 1933, by P. E. Cleator, and which has issued its famous *Journal* since January, 1934. The first number was merely a six-page foldout, but the *Journal* had grown to a 28-page printed magazine by its 12th number

in July, 1939, when the society had a membership of about 100.

During the war the society suspended activities; and the *Journal* resumed publication with Vol. 6, No. 1, a 32-page issue dated June, 1946. Thereafter this periodical appeared quarterly, accompanied by the BIS *Bulletin*. There had been three series of the *Bulletin*, from 1932 to 1937, from March, 1937, to the outbreak of World War II, and from January, 1946, until May, 1947. Then for nearly a decade the *Journal* was the sole organ of the society. The address of the British Interplanetary Society is 12 Bessborough Gardens, London S. W. 1, England.

In October, 1956, the BIS began an illustrated quarterly, *Spaceflight*, larger in format, and with articles intended to appeal to a wider circle of readers. *Spaceflight* can be obtained in the Western Hemisphere from Sky Publishing Corp., Harvard Observatory, Cambridge 38, Mass., for $2.50, four issues; $4.50, eight issues; or $6.00, 12 issues.

Many smaller astronautical groups in Great Britain disbanded when the BIS began its postwar expansion. Their magazines included the *Astronaut* of the Manchester Interplanetary Society, the *Official Bulletin* of the Manchester Astronautical Association, also *Spacecraft* of the Astronautical Development Society, and *Spacewards* of the Combined British Astronautical Societies.

South Africa

Outside the United States and Great Britain, the only important English-language astronautical magazine is the quarterly, *Conquest*, of the South African Interplanetary Society, Box 2330, Johannesburg, Union of South Africa. The first number, of 38 pages, appeared last September. Membership, including a subscription to the magazine, is about $2.25 a year.

Germany

Long one of the leading astronautical organizations, the Gesellschaft für Weltraumforschung (Society for Space Research) changed its name late last year to the Deutsche Gesellschaft für Raketentechnik und Raumfahrt (German Society for Rocketry and Space Travel).

In 1950, the GfW started the journal *Weltraumfahrt*, followed in 1957 by the DGRR's *Raketentechnik und Raumfahrtforschung*. The latter, a quarterly, may be obtained for about $2.50 annually from the society at Neuensteinerstrasse 19, Stuttgart-Zuffenhausen, West Germany. *Weltraumfahrt*, which is still being printed, costs around $2.50 a year from its commercial publisher, Umschau Verlag, Frankfurt am Main, West Germany. Besides being supported by West German societies, *Weltraumfahrt* is the organ of Austrian and Swiss groups who formerly published their own bulletins.

In East Germany, there used to be a group called the Vereinigten Astronautischen Arbeitsgemeinschaften (United

The first issue of this famous journal is today a scarce collector's item.

Astronautical Societies), which in 1950-51 had a magazine *Ad Astra*.

Historically, serious German rocket magazines date back to January, 1927, when the first number of *Die Rakete* was issued by the famous Verein für Raumschiffahrt (Society for Spaceflight). This ceased publication in 1929, and was followed in 1930-31 by a series of *Mitteilungen*, in 1932-33 by *Raketenflug*, and in

Thirty-one years ago, the German magazine, "The Rocket," pictured travel around the earth in 1½ hours — the period of Sputnik I.

1933-36 by *Das Neue Fahrzeug*. *Weltraum*, which appeared in January, 1939, was another of the more important prewar serials.

France

French rocket and astronautical societies have had a long if erratic history. As early as 1927 an astronautics committee was formed within the Societe Astronomique de France, which later had a short-lived astronautics section.

In 1945 another attempt was made by a university flying club to bring together those interested in perfecting the rocket motor and in developing high-altitude missiles. During 1945 and 1946 no fewer than four journals called *l'Astronef* were published. In 1947 astronautical activities were transferred to the Aero Club of France, under the name Groupement Astronautique Francais. Three years later a single issue of a new magazine also called *l'Astronef* was published to coincide with the first International Astronautical Congress, held in Paris, and in 1952 the GAF disbanded.

Later, in 1955, the more professional Societe Francaise d'Astronautique was founded, publishing in April, 1957, its first *Bulletin d'Astronautique*, a large-sized attractive scientific quarterly. It is available with foreign membership for about $5.50 a year from the society, 7 Ave. Raymond-Poincare, Paris 16, France.

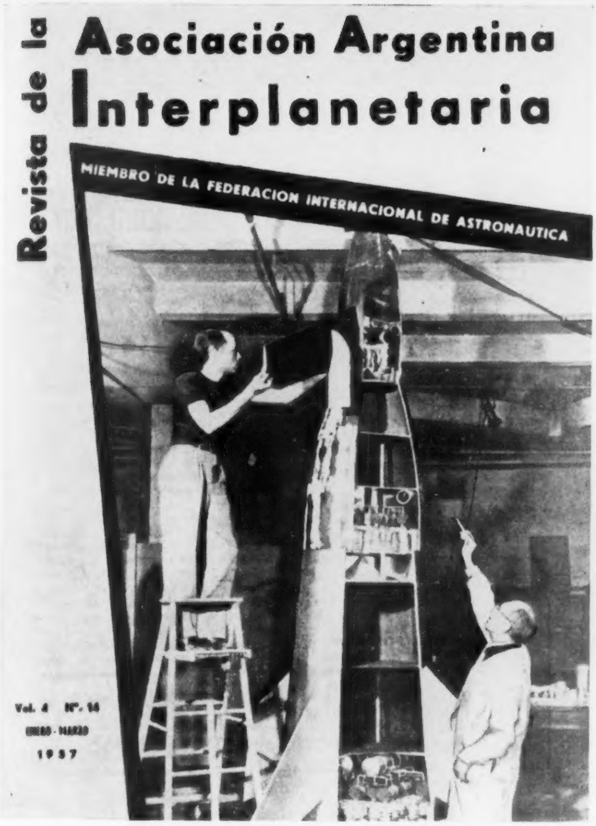
Another current French quarterly, dealing with rockets and astronautics, is *Fusees et Recherche Aeronautique*, published at about $13 per annum by the Association pour l'Encouragement de Recherche Aeronautique, 1 Rue de Courty, Paris 7, France. The first issue was dated June, 1956.

Russia

Two Russian societies dealing with rocketry and spaceflight are known to have been formed in 1929. One was Lengird, a group for the study of reaction motion, founded in Leningrad by N. Rynin and J. I. Perelmann. The other, Mos-gird, was organized in Moscow by I. P. Fortikov. During the thirties there were many technical papers published by these and other groups on rocket technology and upper-atmosphere studies.

Since then, astronautical sections have been set up by the Moscow Aero Club and other organizations. At the top level, the Soviet Academy of Sciences has a well-known permanent interdepartmental commission on interplanetary communications. Technical papers on rockets and spaceflight appear in the academy's proceedings, and also in the magazine *Voprosy Raketnoi Tekniki* (Problems of Rocket Technology), which began in 1951.

Referativnyi Zhurnal: Astronomia i Geodesia (Abstract Journal: Astronomy and Geodesy) contains a section in which brief summaries are printed of important papers on astronautics in the world periodical literature.



Recent issues of two of the most important foreign-language astronautical serials: left, the publication of the Argentine Interplanetary Association; right, "Seisan-Kenkyu" of the Japanese Institute of Industrial Science. All the illustrations of magazine covers with this article are from the author's astronautical library.

Argentina

The largest astronautical organization in any Spanish-speaking nation is the Asociacion Argentina Interplanetaria, Viamonte 867, Buenos Aires, Argentina. The society issues a quarterly *Revista*, each number generally of 48 pages. Membership in the association is $3.00 a year.

Spain

In Barcelona, the Sociedad Astronomica de Espana y America has an astronautical section, which in 1954 inaugurated its *Boletin de Informacion*, appearing at irregular intervals. Its address is Agrupacion Astronautica Espanola, Avenida Generalisimo Franco 377, Barcelona, Spain.

Other Countries

In Brazil there is an active group called the Sociedade Interplanetaria Brasileira, which has published a bulletin at sporadic intervals since 1954. There are other Latin-American societies in Mexico, Chile, and Peru, but without important journals.

The Japanese Institute of Industrial Science, University of Tokyo, puts out an excellent magazine on rocketry, *Seisan-Kenkyu*, often 100 pages long. The Japan Astronautical Society's interplanetary-travel journal is less technical. Among bulletins from other nations are those of the Italian Rocket Association, the Egyptian Astronautical Society, the Swedish Interplanetary Society, as well as the Yugoslavian magazine *Vasiona*.

QUESTIONS... FROM THE S+T MAILBAG

Q. Why does a refractor show a purplish color around a bright object?

A. An achromatic lens can only bring two wave lengths of light to the same focus. When it is in focus for yellow-green light (to which the eye is most sensitive), the red and blue light will be out of focus, giving rise to a purple halo around objects such as Venus and the limb of the moon.

Q. What is a Herschel wedge and how does it operate?

A. It is an unsilvered glass diagonal, the back surface of which is not parallel to the front; it is used for observing the sun. Its front surface reflects to the eyepiece only about five per cent of the light in the converging beam from a telescope's objective or mirror, the remaining light and heat passing through the wedge, which ordinarily has an angle of about 10 degrees. The glass is wedge-shaped so that the unwanted reflection from its back surface does not reach the eyepiece. To reduce the brightness of the sun's image still more, a dark filter must be used in addition to the Herschel wedge.

Q. How are variable stars, such as U Geminorum, UV Ceti, and S Doradus, given their names?

A. The first discovered variable star in a constellation is assigned the letter R, the second S, and so on to Z. Next come RR, RS, and so on to RZ. SS and ST follow, and the letters have this pattern until ZZ is reached. The names then are AA, AB, . . . AZ, BB, and so to QZ, except that there are none containing the letter J. This gives a total of 334 star names. When the letters are exhausted, the designations continue with V335, V336, and so forth. These names are assigned by the International Astronomical Union.

Q. How faint a star can be photographed?

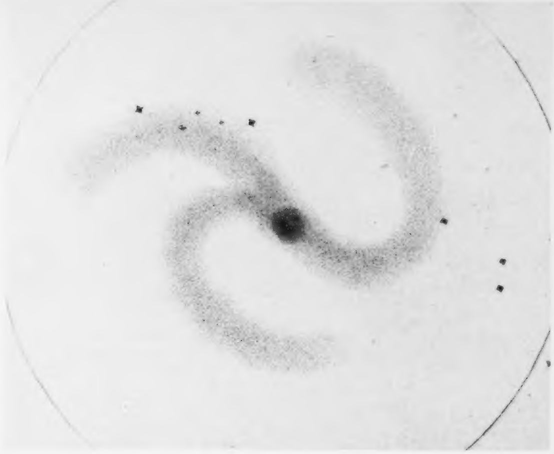
A. The 200-inch telescope at Palomar Observatory can photograph objects as faint as magnitude 23.5.

Q. What is the difference between civil and astronomical twilight?

A. Civil twilight ends when the sun's center is six degrees below the horizon, while astronomical twilight does not terminate until the sun has sunk to 18 degrees.

W. E. S.

Among Southern Galaxies — Messier 83



Lassell's drawing of Messier 83, reproduced from the "Memoirs," Royal Astronomical Society.

ON THE BOUNDARY between Hydra and Centaurus, some 30 degrees south of the celestial equator, lies one of the 10 largest and brightest spiral galaxies in the entire sky. Charles Messier first happened upon it on February 17, 1781, while hunting comets, and inscribed it as No. 83 in his famous catalogue of nebulae and star clusters.

In Messier's very small telescope, this object seemed a faint and featureless nebula, seen only with difficulty. The complex spiral structure, with its star clouds and dark and bright nebulosities, becomes apparent only on photographs taken with large instruments. The visual appearance is better suggested by the two early drawings on this page, by John Herschel in 1834 and William Lassell in 1862.

The Herschel drawing was made at the Cape of Good Hope, where the English astronomer had set up an 18-inch reflector to survey the southern skies. Herschel called particular attention to the nucleus of M83, which appeared to him of the 9th magnitude and about eight seconds of arc in diameter, surrounded by a very large, pale glow.

Lassell drew this object at his temporary observatory on the island of Malta, where he had erected a Newtonian reflector four feet in aperture. Three spiral arms are indicated. M83, therefore, is one of the few galaxies whose spiral structure was recognized before the application of photographic methods.

In total apparent brightness, this great stellar system equals that of a star of photographic magnitude 7.5, according to G. de Vaucouleurs. The brighter portions cover a sky area eight by seven minutes of arc, he finds, but the faint, outer extensions are 14 by 13 minutes.

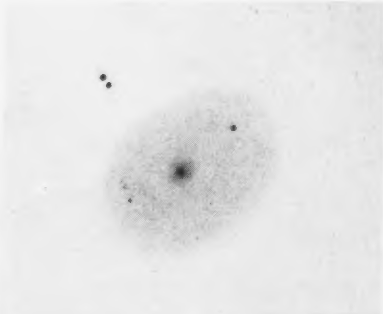
In this picture, the spiral arms are shown partly resolved into numerous stars of the 18th magnitude and fainter, intermingled with patches of nebulosity. Noteworthy is the small, very bright nucleus, whose spectrum resembles that of an *F*-type star, but also contains bright lines detected as early as 1917 by V. M. Slipher at Lowell Observatory. In 1923, a supernova flashed up in M83, and recently this galaxy has been identified as a radio source.

Long ago, E. P. Hubble classified M83 (NGC 5236) as Sc — a spiral with open, loosely wound arms. But the inner portion shows some indications of a bar structure, and Dr. de Vaucouleurs describes M83 as a "typical transition type between the ordinary and barred spirals of intermediate or late type." He calls it SAB (s)c on his new classification system, described on page 582 of last October's *Sky and Telescope.*

M83 has the 1950 co-ordinates: right ascension $13^h\ 34^m.3$, declination $-29°\ 37'$. It is about eight million light-years distant, according to Dr. de Vaucouleurs. Intrinsically it is among the brightest of stellar systems. With an absolute magnitude of about -19.5, it would be similar in brightness to our own Milky Way or the great Andromeda galaxy, M31, if all three systems could be viewed from the same distance.

FACING PICTURE: The spiral galaxy Messier 83, NGC 5236, as it appears in blue light. This is an enlargement of a one-hour exposure with the 74-inch reflecting telescope of Radcliffe Observatory, at Pretoria, South Africa, on August 2, 1956. The reproduction scale is 3½ seconds of arc per millimeter, and south is at the top of the picture.

This is the first in a monthly series of southern-galaxy pictures to be reproduced in this magazine from the new atlas compiled by the Royal Cape Observatory, as described on page 519 of the September, 1957, issue of "Sky and Telescope." Actually, several hundred exposures were made by Cape staff members with the 74-inch reflector, in order to obtain the two dozen high-quality negatives selected for the first installment of the atlas. Each atlas print is accompanied with descriptive material written by David S. Evans. G. de Vaucouleurs, at present on the staff of Lowell Observatory, has supplied "Sky and Telescope" with additional notes. The pictures are being published with the permission of Her Majesty's Astronomer at the Cape, R. H. Stoy. Astronomers may inspect the set of 24 atlas prints at the offices of "Sky and Telescope" in Cambridge, Massachusetts; at the Royal Astronomical Society in London, England; and at the University Observatory, Leiden, Netherlands.



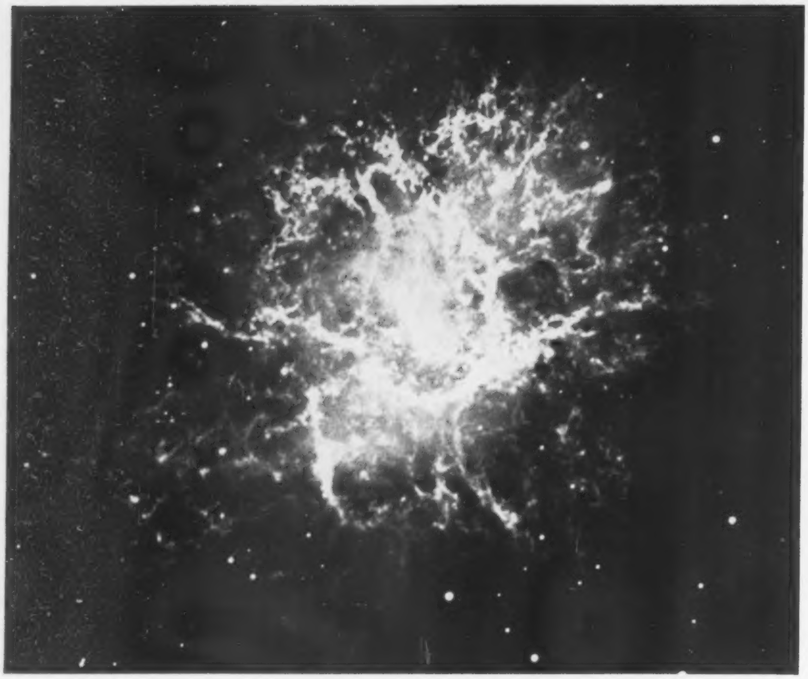
John Herschel's description and sketch of M83, made 124 years ago, indicate no trace of spiral structure. Because he used a front-view reflector, this picture should be turned right for left to match the Cape Observatory photograph on the facing page, or Lassell's drawing above.

WHEN IS MERCURY AT QUARTER PHASE?

Many books erroneously state or imply that Mercury appears exactly half illuminated when at its greatest elongations. M. B. B. Heath, in the October, 1957, *Journal* of the British Astronomical Association, points out that this could happen only if Mercury's orbit were in the same plane as the earth's orbit, and if it were also a perfect circle with the sun at the center.

Mr. Heath gives a simple geometrical explanation of the actual situation, showing that at the moment of greatest elongation the disk of Mercury may be as little as 37-per-cent illuminated, or as much as 63-per-cent.

Similar arguments apply for Venus, but its orbit is very nearly circular, and is less inclined to the ecliptic, thereby making the effect much smaller for this planet. When Venus is at greatest elongation from the sun, the portion of its disk that is illuminated is between 48.7 and 51.3 per cent.



The Crab nebula, photographed by Walter Baade with the 200-inch Hale reflector, using a filter-plate combination to record the spectral region from a wave length of 6400 angstroms to 6700 angstroms. This includes the red light of the hydrogen-alpha line, in which the complex filaments of the nebula radiate strongly. This and the picture below are reproduced from "Bulletin" 462 of the Astronomical Institutes of the Netherlands, 1956.

Modern observations show that the Crab nebula consists in part of luminous filaments with a bright-line spectrum. These are especially striking in photographs taken in red hydrogen-alpha light, and they resemble the filaments of the great Cygnus Loop pictured on page 116 of the January issue.

Much of the light of the Crab comes, however, from a relatively featureless nebulosity that has a continuous spectrum. This amorphous substratum shines by strongly polarized light, as was discovered a few years ago by the Soviet astronomers M. A. Vashakidze and V. A. Dombrovsky. There is no such light from the Cygnus Loop; if it ever existed, apparently it has become extinguished during the 30,000 years or more since that presumed supernova explosion.

The polarized light of the Crab nebula is believed to be synchrotron radiation. Electrons moving at nearly the speed of light are compelled by the magnetic field of the nebula to spiral around and along the magnetic lines of force. This decelerates the electrons, which therefore emit completely polarized light of all wave lengths. Such radiation has been observed from fast-moving particles in laboratory synchrotrons.

There is great present interest among astrophysicists in the details of the processes by which the visible and radio radiations of the Crab nebula are produced.

The Crab Nebula as a Supernova Remnant

OTTO STRUVE, *Leuschner Observatory, University of California*

DID the Loop nebula, the vast expanding wreath of gas in Cygnus, originate in the explosion of a supernova some 30,000 years ago? The probability of this explanation, discussed in last month's article, is strengthened by the similar but better-observed case of the Crab nebula in Taurus.

The Crab nebula lies in the same region of the sky as the bright supernova observed by Chinese and Japanese astronomers from July 4, 1054, to April 17, 1056. Moreover, John C. Duncan's measurements showed the Crab nebula to be expanding, at approximately the rate which would have brought it to its present size if the expansion had begun some nine centuries ago. The evidence relating the nebula and the supernova was reviewed in several articles published in 1942,* when N. U. Mayall and J. H. Oort definitely identified the Crab with the remnants of the star of 1054, "which also probably was one of the brightest supernovae on record."

Another photograph by Baade to the same scale as the one above (about three seconds of arc per millimeter as reproduced), in which the filamentary structure is mostly suppressed. The amorphous body of the Crab nebula is seen instead, recorded in the wave-length region of 5400-6400 angstroms, in this 10-minute exposure. Mount Wilson and Palomar Observatories photographs.

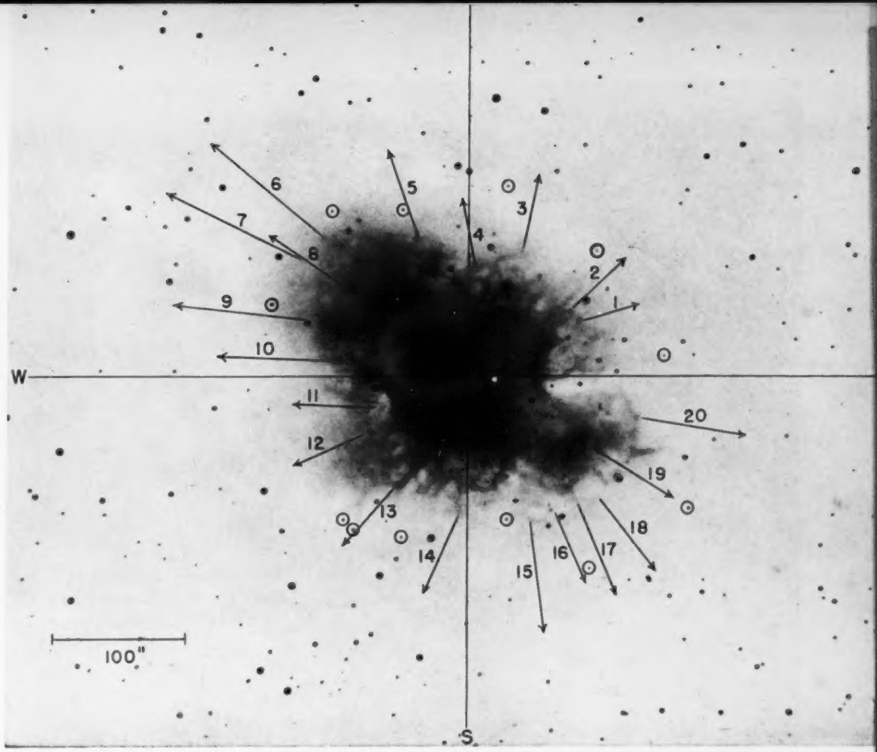
**Publications*, Astronomical Society of the Pacific, *54*, 91, 95, 1942. *Sky and Telescope*, October, 1942, page 3. *Astrophysical Journal, 96*, 188, 1942.

Important studies of this intriguing problem have been made and are in progress by Oort and J. Woltjer of Holland, and W. Baade, J. L. Greenstein, and G. R. Burbidge in the United States, among others. The latest issue of the *Russian Astronomical Journal* (Vol. 34, No. 5, 1957) has two articles on this subject, one by S. Shklovsky, the other by I. M. Gordon. Much of the work is still unpublished, and a summary of it can best be given later.

Oort and T. Walraven find that the mean value of the magnetic induction in the central part of the Crab nebula must be close to 1/1,000 gauss. For comparison, the average interstellar magnetic field is around 10^{-5} or 10^{-6} gauss; the polar magnetic field of the earth is about 0.6 gauss; and the field of a magnetic star may be as large as 10,000 gauss.

The synchrotron theory of radiation by high-speed electrons fits very well with the fact that the Crab is a strong source of radio energy. Apparently, somewhat lower energies are involved than those required for the optical radiation. Thus, 10^9-volt electrons, when decelerated by a magnetic field of 1/1,000 gauss, would produce radio waves with lengths between 10 centimeters and 7.5 meters.

As with the optical radiation, such radio emission should be polarized. Last year, at the Naval Research Laboratory, the team of C. H. Mayer, T. P. McCullough, and R. M. Sloanaker, using a 50-foot parabolic receiver at a wave length of 3.15 centimeters, found polarization of about seven per cent in a position angle close to 149 degrees. This agrees rather well with the over-all value of 9.2 per cent at nearly 160 degrees found in the optical measurements by Oort and Walraven.



The expansion of the Crab nebula, as indicated by measurements made by John C. Duncan. From his photographs with the 100-inch telescope, he has plotted these arrows on a negative print to show motions during the next 500 years, if continued at their present rates. Circles mark the comparison stars used. From the "Astrophysical Journal."

Proof that the light of the Crab nebula is strongly polarized is afforded by the differences between these two 200-inch pictures, taken by Baade through polaroid at different orientations. The arrows show the transmitted light's plane of electrical vibration. From "Bulletin" 462 of the Astronomical Institutes of the Netherlands.

The great Loop nebula in Cygnus was found by D. Walsh and R. Hanbury Brown in 1955 to be a relatively weak radio source, perhaps of the synchrotron type, though the latter suggestion needs confirmation. In any case, we may conclude that whatever supply of *very* fast electrons may have existed during the outburst has disappeared by now, though relatively slower electrons may still be present.

The supernova of 1054 was so brilliant that the Chinese saw it for 23 days by daylight. Its apparent magnitude may have been −6, corresponding to an absolute magnitude of −16 at the adopted distance of about 4,000 light-years. This is intrinsically some 350 million times as bright as the sun! If the supernova parent of the Cygnus Loop had reached this same luminosity, it would have appeared of apparent magnitude −9, that is, brighter than the quarter moon!

Supernovae of type I, those that attain absolute magnitude −16, are exceedingly rare. Only one such object occurs each 200 years in a galaxy like ours, according to Baade and R. Minkowski. In her new book, *The Galactic Novae*, Cecilia Payne-Gaposchkin states that the last object of this kind in our Milky Way galaxy was Kepler's star of 1604. Only a faint, reddened, heavily obscured patch of nebulosity is visible as a remnant of that event. But probably several other such remnants are still observable in the sky. E. Opik has suggested that the great nebulous ring in Orion may have originated in a supernova explosion, and he believes that a similar structure in the Large Magellanic Cloud, described by E. Lindsay, may also be such a remnant.

There are other supernovae, of type II, that differ radically in light curve and spectrum from those of type I. They are more frequent, and the question is still debated whether they are ordinary novae with extreme characteristics, rather than an independent species of star.

Although type-I supernovae are infrequent, our galaxy is so old that it must contain many post-supernovae. Dividing the age of the galaxy, say 6×10^9 years, by the average interval of 200 years between successive supernovae, tells us that there may be about 30 million stellar descendants of former supernovae now in existence. We have no idea what they are like – perhaps they are white dwarfs, but we really cannot tell.

A highly controversial question is the source of the enormous luminosity of a supernova at maximum brightness. It is

Nearly the whole constellation of Orion appears wreathed in nebulosity, as shown in this five-hour exposure by F. E. Ross with a wide-angle lens of his own design. The belt of Orion and the Orion nebula are just above and below the center. The great loop of luminous gas in this view is regarded by some astronomers as the result of a supernova outburst many thousand years ago. Yerkes Observatory photograph.

believed that in an ordinary nova only the outermost layer of the star is blown off. As long as this layer is dense enough to remain opaque, it shines like the photosphere of a star, and its rapidly increasing surface area satisfactorily explains the sudden rise in brightness of the nova. But for supernovae the problem is more intricate.

In the first place, we have already seen that most of the present light of the Crab nebula is of nonthermal origin; it can be accounted for only by the synchrotron light of fast electrons. Perhaps, then, the light of the supernova explosion itself was synchrotron radiation.

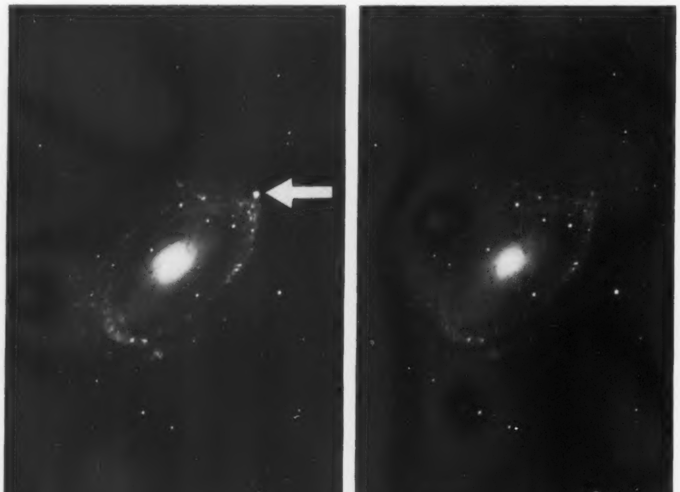
This viewpoint was urged by the Soviet astronomer Gordon, even before anything was known about how the Crab nebula shines. It has not been tested by direct observation, for no bright galactic supernova has been observed by modern means during its outburst. Even the famous supernova of 1885 in the Andromeda galaxy was observed only visually, apart from a lone Harvard photograph. Our information concerning the spectra and light curves of supernovae comes almost entirely from the 50 or so objects discovered during recent years in very distant galaxies.

A typical supernova of type I at maximum brightness has a spectrum containing very broad, as yet unidentified, emission features. Their widths suggest a velocity of expansion of the order of 10,000 kilometers per second. A few months later, while the supernova is fading, the spectrum shows emission lines of neutral oxygen, whose comparative narrowness indicates velocities of about 1,000 kilometers per second. A deceleration from 10,000 to 1,000 kilometers per second within a few months cannot be explained by the braking action of interstellar clouds, or by the star's own gravitation. It may have something to do with magnetic fields, such as are known from observation to exist in the Crab nebula.

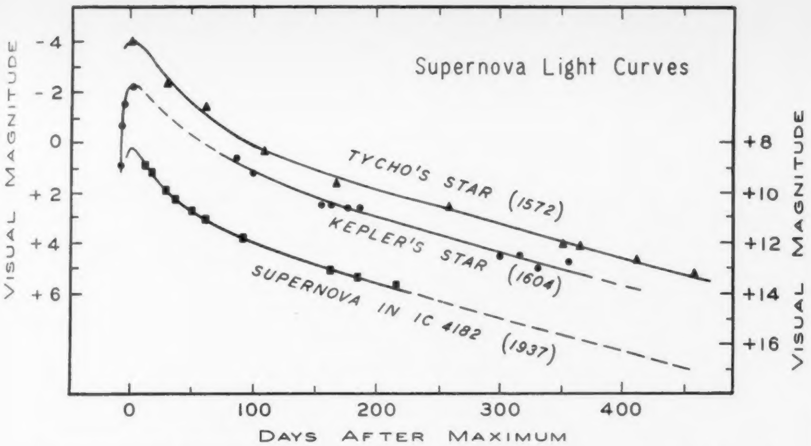
The brightening of a supernova is exceedingly rapid, taking perhaps 10 days or 10^6 seconds. If we assume that the average velocity of expansion is 5,000 kilometers per second, then the outward distance traveled by the shell would be 5×10^9 kilometers during the 10 days. We know nothing definite about the radius of the presupernova, but perhaps it is roughly that of the sun, say a million kilometers. Thus during the explosion the radius of the star has increased 5,000 times, and its surface area by 25 million times.

Now, if the blown-off shell continues to radiate as a black body with the star's initial temperature, the luminosity will have increased by this same factor of 25 million. In stellar magnitudes, this would be a brightening of 18.5. If the absolute magnitude of the supernova at maximum were -16, that of the star before the explosion would have been $+2.5$. While this may seem a little too luminous, we have no good reason for preferring some other specific number.

But Gordon has pointed out some rather disturbing facts. First, the shell ejected by the supernova contains a large fraction of the original material of the star. It must therefore have an average temperature far higher than that for any normal star – perhaps as much as one million degrees. If the surface temperature of the presupernova was 10,000 degrees, then the total radiation from each



The arrow marks a supernova that flashed up in the year 1940 in the spiral galaxy NGC 4725, a member of the Ursa Major group. No star is visible in the corresponding place on the other picture, obtained in 1931. Mount Wilson and Palomar Observatories photographs.



All supernovae of type I have remarkably similar light curves. Baade's diagram illustrates this for three supernovae. The first two were in our own Milky Way: one in Cassiopeia observed by Tycho Brahe in 1572 to 1574; the other Kepler's star of 1604 in Ophiuchus. The third appeared in 1937 in the galaxy IC 4182. The magnitude scale at the left is for the two upper curves, at the right for the lowest curve. Adapted from the "Astrophysical Journal."

square centimeter of the shell would be 10^4 greater than from the same area on the original star. However, most of this would be of very high frequency, and in visible light the surface brightness of the shell would be only 100 times greater than for the star. Thus, in visual light the increase in brightness would be 100 times more than our previous calculation gave, corresponding to five magnitudes. The total brightness change would be 23½ magnitudes.

This result is not unreasonable; it would require the absolute magnitude of the presupernova to be +7.5. But there are serious contradictions. How can we reconcile the million-degree temperature with the fact that supernovae at maximum have color indices matching those of *A*-type stars, whose temperatures are about 15,000 degrees? And why can we soon after maximum observe spectral lines of neutral oxygen, which require a relatively low temperature?

It seems to me that we cannot yet be certain which mechanism produces the light of a supernova, but Gordon's ideas have much to recommend them. Mrs. Gaposchkin believes that the visible radiation of type-I supernovae is not of thermal origin.

It is over 350 years since the last supernova in our galaxy was recorded. The appearance of another one in our Milky Way system would enable the powerful observational tools of modern astrophysics to be applied to the problem of why and how they explode, and would also provide the most striking celestial spectacle in many years.

Since the appearance of last month's article on the Cygnus Loop, Dr. Minkowski has informed me of his most recent work on it. He finds that the radial velocities of the bright filaments and patches range between 65 kilometers per second at the inner boundary of the expanding shell, which has a diameter of about 80 minutes of arc, and 115 kilometers per second at the outer boundary, whose diameter is about 170 minutes of arc. Combined with Hubble's value for the proper motion of expansion of 0.03 second of arc per year, Minkowski's measures give a distance to the Cygnus Loop of 770 parsecs (2,500 light-years).

Minkowski has also measured the intensities of the hydrogen emission lines in the Loop nebula, and has now confirmed Oort's original suggestion that the excitation is caused by the collision of the expanding nebular shell and the interstellar clouds of dust and gas. This conclusion agrees with the work of S. B. Pikelner in Russia and S. Miyamoto in Japan.

The Mount Wilson and Palomar astronomer's concept of the Loop nebula is otherwise quite similar to the one presented in the January article, except that Minkowski regards the original outburst as having been caused by a supernova of type II. This is still somewhat uncertain, and may require further consideration in these pages.

It is of interest that Minkowski finds that several other objects resemble the Cygnus Loop. They are IC 443, the radio sources HB 9 and HB 21, and the filamentary nebula S147.

POSITION AVAILABLE AT GRIFFITH OBSERVATORY

The post of associate director of Griffith Observatory becomes vacant April 1st, and will be filled by a city of Los Angeles civil-service examination. The requirements are a doctorate in astronomy or other physical science, and two years professional experience in astronomy, including planetarium lecturing.

Applications and $1.00 filing fee must be received in Room 5, City Hall, Los Angeles, Calif., by February 18, 1957; or at the information window, Van Nuys Branch City Hall, by the same date.

12 LACERTAE CAMPAIGN

From August 28 to September 12, 1957, a world-wide chain of 15 observatories maintained a co-operative photoelectric patrol on a puzzling variable star, in an effort to obtain a continuous record of its brightness changes. The variable star was 12 Lacertae, one of about a dozen known members of the Beta Canis Majoris type. Its principal period is 4.6 hours, but there are superimposed periodicities of 4.7 and 3.8 hours, and a fourth one of 3.9 hours has been suggested.

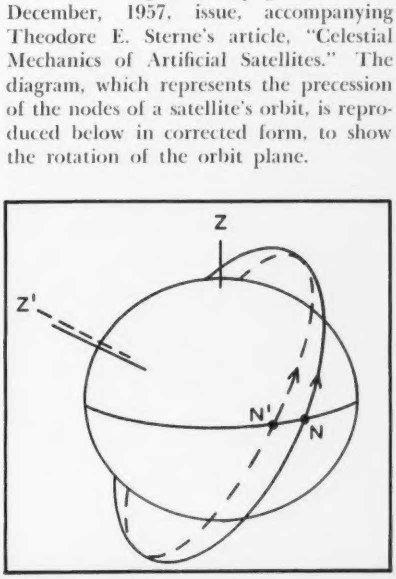
The light curve is therefore exceedingly complex, and is difficult to interpret from observations made at a single geographical location, at which the star can be followed photoelectrically for only a few hours out of the 24 in each day.

Five of the co-operating stations were in the United States: Mts. Wilson and Palomar, Berkeley, New Haven, and Dannemora, New York; two were in Canada at Victoria and Richmond Hill. Other participating observatories were at Dublin, Ireland; Utrecht, Netherlands; Trieste and Merate, Italy; Bialkov, Poland; Simeis and Abastumani, U. S. S. R.; and Tokyo, Japan.

Successful completion of the observing campaign was announced in the November 23, 1957, issue of *Nature* by a letter bearing the signatures of 20 astronomers who participated. Analysis of the photoelectric records, and of radial velocity observations obtained during the same season, is being carried out by C. de Jager, of Utrecht Observatory.

CORRECTION

Several readers have pointed out a mistake in a diagram on page 67 of the December, 1957, issue, accompanying Theodore E. Sterne's article, "Celestial Mechanics of Artificial Satellites." The diagram, which represents the precession of the nodes of a satellite's orbit, is reproduced below in corrected form, to show the rotation of the orbit plane.



Radio Echoes from the Moon

A familiar sight from a busy intersection in downtown Urbana is the moon-experiment antenna on the roof of the University of Illinois' new electrical engineering building. This picture was taken in August, 1957, during the American Astronomical Society's meeting on the university campus. The dipole and the reflecting corner can be seen near the top of the structure, at the focus of the antenna. The picture at the foot of the page shows an earlier stage in the construction of this radio telescope, which can also be used to observe the sun and discrete radio sources.

RADIO SIGNALS reflected from the moon are to be studied with a 28-foot antenna at Urbana, Illinois, mounted on the roof of the electrical engineering building of the University of Illinois.

The radio energy will be transmitted from the Evans Signal Laboratory, Belmar, New Jersey, where the first American observations of radio reflections from the moon were made in 1946 (Project Diana). Harold D. Webb, associate professor in charge of the present experiments at the University of Illinois, was on the scientific staff that conducted Project Diana.

At Belmar, a parabolic reflector-type antenna, 50 feet in diameter, is used for both transmitting and receiving, at a frequency of 151 megacycles (between channels 6 and 7 of the television bands). The transmitting power is 40,000 watts, but this is greatly attenuated by the moon's distance, and only about 100 watts are received by the lunar hemisphere that is facing the sending antenna. Of this, probably about 10 watts are reflected by the moon, only a very small fraction in the direction of the Illinois antenna, which therefore concentrates a lunar echo of only about 10^{-15} watt at the receiver input terminals.

The University of Illinois antenna is a parabolic reflector also, 28 feet in diameter, built by D. S. Kennedy Co. It is supported by a steel tower 17 feet high, and on this tower are motors to turn the reflector in azimuth and altitude, from about five degrees below the horizon to that far beyond the zenith. At the reflector's focus, the antenna feed is supported by a tripod of laminated fiberglass, which offers no interference to radio energy. The feed structure is a dipole, cut for 151 megacycles, and matched to the transmission line by a balun type of transformer.

To increase the over-all gain of the antenna, the dipole is located in a corner reflector, the corner being very near the focus of the paraboloid. By this arrangement the antenna is strongly directional, the half-power points in the directive pattern being about 20 degrees apart on the main lobe.

Located within the building and just below the antenna is the very sensitive receiving apparatus. This consists of a low-noise preamplifier, a frequency converter to change the signal from 151 to 15 megacycles, and a stable communications receiver. Usually the receiver is operated with a band-width of 100 or 1,000 cycles. With the former, the signal-to-noise ratio is about 30 decibels for a 10^{-15}-watt signal.

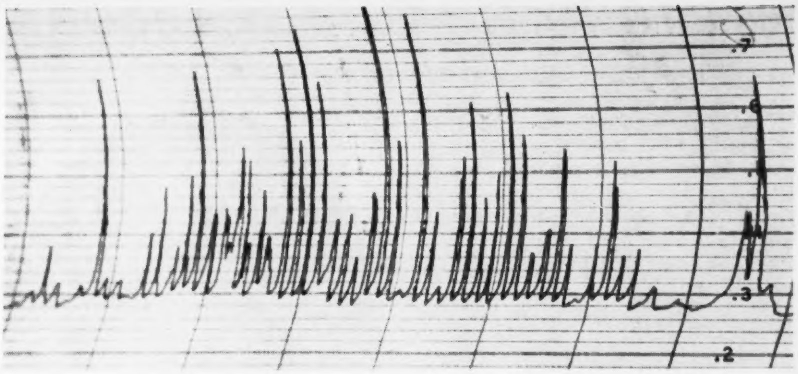
Already, lunar echoes have been recorded for the purpose of testing the method and calibrating equipment. In the accompanying record each spike represents a one-second pulse. The differences from pulse to pulse are quite apparent, and there are indications of a slower signal variation.

Professor Webb's group plans to investigate how the signal strength alters with the moon's position in the sky and with

Here a crane is being used to assemble the reflector, which is 28 feet in diameter. It has a welded-aluminum frame covered with aluminum mesh. Weighing approximately 1,100 pounds, it is carried by a steel tower whose base is 17 feet below the center of the dish. Heavy counterweights balance the dish on the horizontal axis. University of Illinois photograph.

the moon's phase. The change in polarization of the signals is related to the electron density in the earth's ionosphere. This kind of information may help in developing methods for relaying radio and television signals to half the earth at one time. This project is being sponsored by the U. S. Army Signal Corps.

Since the moon is in the sky during the day much of the time, normal working schedules will be used at the laboratories. Transmissions will be carried out during one week of each month, with the other three weeks devoted to analysis of the signal records. Meanwhile, the antenna can be used for observations of the sun and discrete radio sources. It can track American artificial satellites at 108 megacycles, at times when the horizontal range is 500 miles or greater.



One-second radio pulses, recorded here, have traveled half a million miles from New Jersey to Illinois via the moon, taking $2\frac{1}{2}$ seconds for the journey. This sample tape covers a transmitting period of about eight minutes. University of Illinois photograph.

LETTERS

Sir:

Even under perfect conditions, very little can be seen upon the surface of Venus, and it is extremely difficult to tell which of any observed markings are real and which are illusory. I would like to add my comments to the discussion of this problem on page 588 of the October, 1957, *Sky and Telescope*.

Contrary to the statements made by some observers, I have found that, when conditions are good or fairly good, an increase in aperture is always accompanied by an increase in visibility of planetary features. My own telescopes are $12\frac{1}{2}$- and $6\frac{1}{2}$-inch reflectors and a 3-inch refractor, and I have also made extensive observations with larger telescopes of up to 33 inches aperture.

Among the true features of Venus, I class the elusive dark shadings and the brighter areas. The main reason, to me, is that they change. When an observer studies Venus with an adequate telescope, say a 12-inch, he does not record certain shadings and cusp caps in the same way night after night as he would if such features were illusions. Occasional features are so prominent that it is impossible to dismiss them as illusory, such as the persistent bright patch discovered in 1956 by R. L. Waterfield.

Like Spangenberg, I have experimented in making drawings of a featureless model of Venus observed at a considerable distance with my 3-inch refractor. Unlike him, I have never been able to see features on the blank globes, apart from spurious brightenings near the edge (not cusp caps). Quite possibly I fail to see spurious markings simply because I know they are not there; for the opposite reason, others might draw them. No reliable conclusions can be reached until such experiments have been carried out by many observers, since unconscious prejudice is very difficult to eliminate.

Several reported features of Venus I regard as false, such as the dark wheel-spoke system reported by some observers, and the definite markings described by Lowell. I have never seen the wheel spokes, but have noted well-defined central blotches on Venus as well as brightish blobs, but only with small instruments. With larger apertures these features disappear, while the elusive shadings are enhanced. These experiments of mine have been going on for more than 10 years, and hundreds of determinations have been made, always with the same result.

It often happens, of course, that the disk of Venus appears completely blank, even when conditions of observation are excellent. I think that most experienced observers have found the same thing; it is a phenomenon of Venus itself, and has nothing to do with defective eyesight or equipment.

Until recently Venus has been neglected in favor of Mars, Jupiter, and Saturn, but now much more attention is being paid. There is still much we do not know, and I believe that the visual observer with a moderate telescope still has an important role to play.

PATRICK MOORE
Director, Mercury and Venus Section
British Astronomical Association

Sir:

On page 15 of the November, 1957, issue, in my article on the great aurora of September 22-23, I discussed the odd gaps shown in the pattern of auroral observations transmitted at the end of hourly weather reports. Subsequent investigation, using direct questionnaires to supplement the airways teletype reports I had used, showed that these gaps were entirely accidental.

As stated in the article, regulations on reporting auroral observations had recently been changed, and uniform reporting practice is not yet attained. Quite by chance, the observers in those gaps were following the new instructions of *not* filing teletype auroral reports. This confirms my statement that aurora may not have been positively absent at those locations.

I might also add that information provided by staff members of the department of meteorology, Florida State University, indicates that not Douglas, Arizona, but Palm Beach, Florida, may have been the lowest-latitude location at which aurora was observed on the night of September 22-23.

JAMES E. McDONALD
Institute of Atmospheric Physics
University of Arizona
Tucson, Ariz.

Sir:

Amateur astronomers who own or have access to suitable radio equipment will be interested in the informally organized Science League, which has been meeting daily on 3525 kilocycles at 6 p.m. Eastern standard time and on 7125 kilocycles at 9 p.m. EST.

We relay scientific information to member clubs and to individuals, and we also act as a clearinghouse for sightings of artificial satellites, fireballs, comets, auroras, and the like. Anyone wishing to join the league is automatically a member. There are no dues at present, but to cover running expenses we expect to arrange a formal membership.

The Science League is basically not a ham-radio operation, but an activity of amateur scientists who are also amateur radio operators.

Crystals for the 3525- and 7125-kilocycle frequencies may be secured from radio-supply shops, or may be purchased from the undersigned at $3.00 each or $5.00 for the pair.

NELSON M. GRIGGS
R. D. 2, Old Baltimore Rd.
Boyds, Md.

CORRECTION

The table on page 127 of the January issue gives the brightest and faintest magnitudes of RU Pegasi as 9.4 and 14.4. These should read 10.0 and 13.1.

ASTRONOMICAL SCRAPBOOK

Navigators of the Old Pacific

TO OBSERVE the transit of Venus on June 3, 1769, James Cook stopped at Tahiti on his voyage around the world in HMS *Endeavour,* which he commanded. There, on a promontory still known as Point Venus, his party set up their telescopes and timed the passage of the planet across the sun's disk.

On this expedition and his two later voyages into the Pacific, the great English explorer became acquainted with a much-discussed historical puzzle that remains unsolved even today. This is the "Polynesian problem."

The European discoverers in the Pacific found that all inhabited islands in the southern and eastern part of the vast ocean were occupied by brown-skinned, black-haired people who spoke closely related languages. (Incidentally, the lunar crater Wilhelm von Humboldt bears the name of the first scientific investigator of Pacific tongues.) Some of these islands, which are scattered as widely as from New Zealand to Hawaii and to Easter Island, are well over 1,000 miles from any other inhabited land. How did the Polynesians and other Pacific islanders get to their remote and isolated homes?

The era of oceanic colonization must have been comparatively recent historically. The earliest human occupation of Hawaii was as late as about A.D. 1000, according to the radiocarbon method of dating ancient objects. The corresponding date is approximately 1500 B.C. for the Marianas Islands, more than 3,000 miles to the west.

Capt. James Cook's 1768-1771 circumnavigation of the globe in the 370-ton bark HMS "Endeavour" was marked by many discoveries. This portrait is from the frontispiece of Cook's "A Voyage to the Pacific Ocean," printed at London in 1784.

The spread of the Polynesians across the broad Pacific has excited considerable admiration for their skill as navigators with very primitive means. Ignorant of the compass or other instruments, they used the stars and the direction of wind and waves as guides on extended voyages in their great seagoing double canoes.

Just what navigational techniques did these travelers use? This problem has been studied by several astronomers, including Maud W. Makemson, of Vassar College Observatory, who wrote an absorbing book on the subject, *The Morning Star Rises* (1941).

The best clues come from the descriptions of the islanders' navigation as preserved by Captain Cook, and by other explorers of around 1800, before European techniques had supplanted native ones. The Tongans told Cook that on their voyages to Fiji and Samoa they found their bearings from the stars, and when the sky was overcast they depended on the direction of the wind and waves.

Generally, the pole star was not available as a guide, for most of the Pacific islands lie south of the equator. In the Caroline Islands, however, Polaris appears a few degrees above the horizon, and native pilots used it to find directions, and estimated its altitude for a rough idea of latitude. Bearings seem to have been usually found from stars whose rising or setting points on the horizon lay in the same direction as the destination.

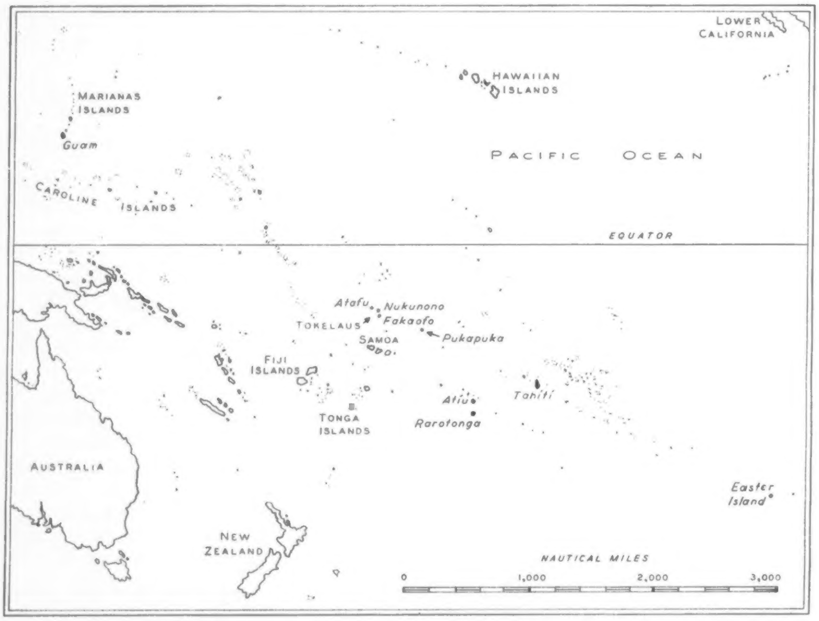
John Williams, who was a missionary to the central Pacific over a century ago, recorded how the people of Atiu used to find their way to Rarotonga, 116 miles to the south. On their home island, they had selected two landmarks indicating the bearing to Rarotonga. In the afternoon, the voyagers would follow the course fixed by these landmarks until they faded from sight, and when darkness fell would take their direction from the stars.

It is often stated that with simple methods like this the early Polynesians could make two-way journeys between places as separated as Tahiti and New Zealand, more than 2,000 miles apart. But these feats of navigation have been much exaggerated, it is argued by a New Zealand historian, Andrew Sharp, in his *Ancient Voyagers in the Pacific*, published two years ago. The primitive navigational techniques just described are really adequate for only short voyages of a few hundred miles at most, he maintains.

On longer trips the effects of crosscurrents and wind changes could not have been properly allowed for, making it quite possible to pass to one side of a distant island destination, out of sight below the horizon. Routine, two-way travel between very distant points would not have been feasible. Hence, according to Sharp, the more remote islands could have been settled only by blind search, or by canoes blown from course—not by planned colonizing expeditions.

Sharp describes an involuntary migration, one example out of many: "In 1696 a large canoe came on an accidental journey from the Carolines in the North Pacific to the Philippines, having been

(*Continued on page 183*)



This sketch map of the central and eastern Pacific Ocean identifies the islands mentioned in the text. From Samoa to Hawaii is over 2,200 miles. Did the early Polynesians who settled the remoter islands travel such distances with the aid of precise astronomical navigation methods? The question has been much argued by astronomers and historians.

NEWS NOTES

SEARCH FOR INTERSTELLAR DEUTERIUM

For several years there has been doubt among astronomers as to whether or not the interstellar gas, which is mainly ordinary hydrogen, contains an appreciable fraction of deuterium—heavy hydrogen of atomic mass two (*Sky and Telescope*, May, 1956, page 307).

This problem was recently attacked by J. S. Hey and R. L. Adgie, of the Royal Radar Establishment, Malvern, England. They pointed an aerial of 25-foot diameter toward the galactic center, to see if the radio spectral line of deuterium at 91.6 centimeters was detectable. Because the center of the Milky Way system is a strong radio source, any intervening deuterium gas would produce an absorption line in the bright background radiation.

According to the report in *Monthly Notices* of the Royal Astronomical Society, no definite indication could be found of interstellar deuterium. Its abundance does not exceed 1/2,000 that of ordinary hydrogen, according to Drs. Hey and Adgie. For a more sensitive test, a precision 45-foot parabolic antenna and an improved receiver have been constructed.

ORBIT OF NEREID

The 19th-magnitude outer satellite of Neptune is unique among the moons of the solar system. Not only is its orbit more elongated than that of any other known satellite, but Nereid travels around Neptune in a direction opposite to the brighter inner moon, Triton.

At McDonald Observatory, George Van Biesbroeck has completed a study of Nereid's orbit from 37 photographs with the 82-inch reflector, the same telescope with which G. P. Kuiper discovered the object in 1949. According to Dr. Van Biesbroeck's report in the *Astronomical Journal*, Nereid requires 359.881 days to complete one revolution around Neptune, at a mean distance of 0.0372 astronomical unit, or about $3\frac{1}{2}$ million miles. Since the orbital eccentricity is 0.749, this distance varies between 0.9 and 6.0 million miles.

The mass of Neptune deduced from the motion of Nereid comes out 1/18,889 the mass of the sun. This makes the planet about two per cent more massive than had been previously believed, but older results, based on observations of Triton, were affected by large systematic errors.

NATIONAL OBSERVATORY CONTRACT AWARDED

The National Science Foundation has approved a contract with the Association of Universities for Research in Astronomy, Inc., to carry out basic research in astronomy and to build, operate, and maintain the National Astronomical Observatory. The foundation's appropriation for the fiscal year 1958 includes over three million dollars for this project.

Seven universities have joined to form the new association: California, Chicago, Harvard, Indiana, Michigan, Ohio State, and Wisconsin. The president of AURA, Inc., is Dr. Robert R. McMath, director of McMath-Hulbert Observatory, and the vice-president is Dr. Frank K. Edmondson, director of Goethe Link Observatory. The association was incorporated in Arizona last October, and has its principal office in Phoenix.

The selection of a suitable observatory site has been narrowed to three locations in Arizona. Two of them, Kitt Peak and the Hualpai Mountains, are among those heretofore under survey (*Sky and Telescope*, August, 1957, page 482), and the third is a new possibility: Mormon Mountain, 35 miles south of Flagstaff.

VISITING PROFESSORS TO TOUR COLLEGES

This month the American Astronomical Society will begin a program of visiting professors in astronomy. Made possible by a grant from the National Science Foundation, the innovation is designed to strengthen college programs in astronomy, to stimulate the exchange of astronomical information, and to encourage college students to consider careers in astronomy and related fields.

The visiting professors will give general college lectures, talks to astronomy classes, and will participate in seminars. They will also advise students on the opportunities for advanced study and employment in astronomy, and will discuss teaching problems and curriculum with faculty members. The visit to each college will usually last for two or three days.

Dr. Paul W. Merrill will be available from February through May for colleges in the Far West; Dr. Seth B. Nicholson, from February through May in the Middle West; and Dr. Harlow Shapley, during February and March in the East. Further information may be secured from Dr. William Liller, University of Michigan Observatory, Ann Arbor, Mich.

ARTIFICIAL SATELLITES IN 1946

L. C. Eichner, Clifton, New Jersey, has called attention to an interesting forecast of the uses of artificial satellites, in a paper read before the Finnish Academy of Sciences on February 8, 1946, by Y. Vaisala, of Turku University. The Finnish astronomer was discussing how accurate geodetic triangulations could be obtained with the aid of a light source high above the earth's surface. He said, in part:

"If rocket missiles can be developed to such a degree that it would be possible to realize small moons which would circle the earth at an altitude of some thousands of kilometers with a period of only several hours, we should obtain practically eternal light sources for a giant triangulation and these light sources could also be used for physical measurements of the earth. A simple calculation reveals that an artificial moon several decimeters in diameter could be followed with medium-sized apparatus. The light flashes necessary for accurate observations would be furnished by the artificial moon if one half of it were white, the other black and if it were given a suitable rotatory motion."

Professor Vaisala's paper is available as *Reprint* No. 2 of the Astronomical-Optical Institute of Turku University, Turku, Finland.

IN THE CURRENT JOURNALS

SOME CHARACTERISTICS OF THE UPPER ATMOSPHERE PERTAINING TO HYPERVELOCITY FLIGHT, by C. Frederick Hansen, *Jet Propulsion*, November, 1957. "The chemical processes which occur in the air are discussed relative to their effects on the density and temperature structure of the atmosphere. . . . Because of the low density most of the aerodynamic force and heat transfer effects become secondary above 60 miles altitude, for vehicles traveling at speeds up to escape velocity. [Meteors and cosmic particles] will probably not prohibit manned flight through the upper atmosphere."

PROBLEMS OF LAUNCHING AN EARTH SATELLITE, by Martin Summerfield, *Astronautics*, November, 1957. "This careful examination of the technical considerations inherent in any such project reveals the magnitude of the engineering feat accomplished by the Russians in the successful 'Sputnik' launching."

SPACE VEHICLES AS TOOLS FOR RESEARCH IN RELATIVITY, by S. Fred Singer, *Journal of Astronautics*, Autumn, 1957. "My conclusion . . . is that a man living in a satellite would actually live slower, and when he finally descends to earth again, he will be younger. . . .The shift of the satellite clock is very small – less than one part in a billion. And it turns out, if you do it numerically, that in a life span of 100 years you would gain exactly one second."

THE SATELLITE LAUNCHING VEHICLE–PLACING THE SATELLITE IN ORBIT, by John P. Hagen, *Griffith Observer*, December, 1957. "The Satellite Launching Vehicle will be called upon to establish an artificial satellite in an orbit around the earth during the International Geophysical Year. Succeeding problems are to prove that it is indeed there and to perform scientific experiments using the satellite."

Amateur Astronomers

Some Satellite Observing Statistics

MANY amateurs and MOONWATCH teams around the world have made an impressive record of artificial satellite observations. For instance, as of December 17, 1957, the MOONWATCH station of the Astronomical Society of Western Australia had obtained 144 separate observations of Sputniks I and II, according to a letter from group leader Ronald W. Boggis.

A recent Smithsonian Astrophysical Observatory compilation summarizes part of the world-wide visual observing effort. This report lists organized sightings of Sputnik I between October 8 and November 27, 1957. During this interval of 51 days, MOONWATCH teams secured 582 visually determined positions, 399 in the United States, 148 in Japan, 33 in Australia, and two in Chile.

The largest numbers of United States sightings of Sputnik I were obtained from teams in Massachusetts, with 67 reports; California, 51; Texas, 48; Kansas, 20; New York and Ohio, 15 each; Oklahoma and Virginia, 14 each. Most of the observations were of the bright third stage (1957α1), but there were 46 of the spherical satellite (1957α2), and two station reports of the rocket's nose cone (1957α3).

On the evening of November 23rd, the Portland, Oregon, team saw the third-stage rocket occult the star Delta Cassiopeiae, while two nights later an occultation of Eta Cassiopeiae was seen from Albuquerque, New Mexico. Another unusual sight on November 25th, at Wichita, Kansas, was the passage of 1957α1 tangent to the bottom of the moon's disk, according to the Smithsonian summary.

VARIABLE STAR OBSERVERS

During the 12 months ending on September 30, 1957, the American Association of Variable Star Observers received 46,238 observations from 123 persons in 13 countries. Approximately 900 known and suspected variables were under watch, according to the 26th annual report of the AAVSO director.

Foreign observers contributed 28 per cent of all magnitude estimates, the other 72 per cent being submitted by 105 participants in 28 of the United States. For the fourth consecutive year, the most active observers were R. P. de Kock, of South Africa, with 7,257 estimates, and Edward Oravec, Tuckahoe, New York, with 5,712.

A revised edition of the *Manual for Observing Variable Stars* has been prepared by the director, Mrs. Margaret W. Mayall. In addition to general information, the booklet contains examples of finder charts for several variable stars, and may be purchased for $1.00 from the AAVSO, 4 Brattle St., Cambridge 38, Mass.

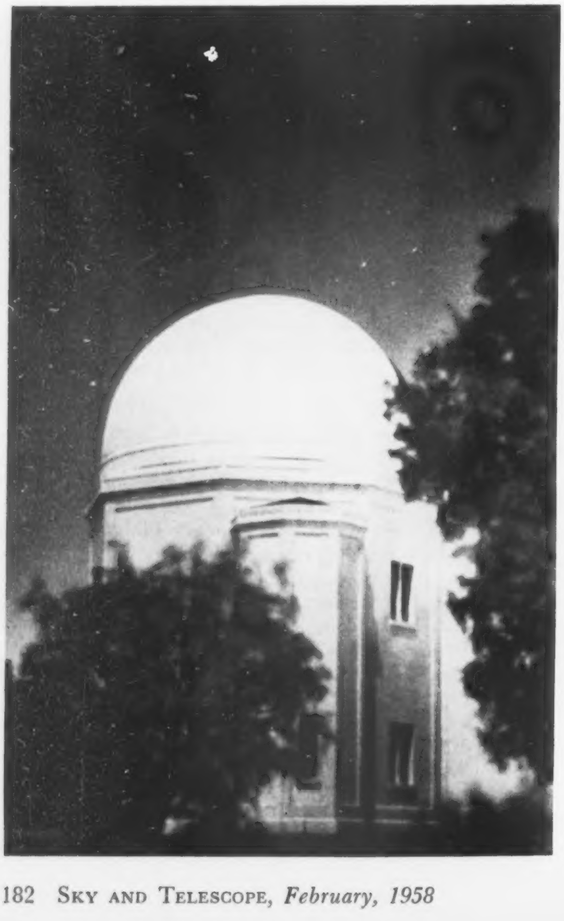
A TELESCOPIC VIEW OF A SATELLITE ROCKET

On the evening of November 24, 1957, as the zero-magnitude rocket of Satellite 1957α appeared in the western sky, it was followed through a 3-inch refractor by Bob McCracken, of the Springfield, Virginia, MOONWATCH team. In the half-degree field of the telescope, at 80x, the rocket appeared as a bright line segment about five minutes of arc long. It seemed to be slowly tumbling or rotating in a clockwise direction, a quarter of a turn taking about one minute.

This observation was reported in the December issue of *Star Dust*, published by the National Capital Astronomers, Washington, D. C.

ST. LOUIS, MISSOURI

A series of 11 lectures on basic astronomy is being offered to members of the St. Louis Astronomical Society. In addition to dealing with the concepts and vocabulary of astronomy, the course offers a background to observing techniques. The meetings have drawn an average attendance of 45 members.



Sputnik II is seen crossing the same constellations on three successive mornings in these photographs by Don Strittmatter, Tucson, Arizona. The first picture, upper right, was taken December 11, 1957, at 5:52 a.m. Mountain standard time. The second, left, at 5:37 a.m. on the 12th; that in the lower right at 5:23 a.m. on the 13th. Mr. Strittmatter observed from the grounds of Steward Observatory, whose 36-inch reflector dome appears in the second view. All pictures were taken with a Speed Graphic press camera equipped with a 170-mm. f/2.5 Aero-Ektar lens, on Royal-X Pan film and developed for 12 minutes in Ethol 90.

AAVSO SOLAR DIVISION "SEA" PROGRAM

The Solar Division of the American Association of Variable Star Observers is co-operating with the United States IGY program to record sudden enhancements of radio atmospherics (SEA's). Early results of the program are reported in the division's *Solar Bulletin* for September-October, 1957.

Seven stations are now in operation, using transistorized SEA detectors designed by David Warshaw. These radio receivers record any change in the amount of "noise" at a frequency of 27 kilocycles (wave length about seven miles). At such long wave lengths most noise is atmospheric in origin, much of it being produced by distant thunderstorms. When a flare occurs on the sun, the radio-transmitting characteristics of the earth's ionosphere change, and the noise increases in intensity due to improved reception at low frequencies. The output of the SEA detectors is fed into pen-recording units to give easily handled records.

Harry L. Bondy, chairman of the AAVSO Solar Division, stresses that the amplitude of an SEA is not necessarily related to the magnitude of the flare. Other factors affect SEA's also. For example, recordings by Philip J. Del Vecchio, Paterson, New Jersey, show the "sunrise pattern": There is a slight dip in the tracings about 35 to 45 minutes before sunrise; then a distinct rise about 20 minutes before the sun comes up; and finally, as the sun rises, a distinct drop. There seems to be no corresponding "sunset pattern."

BROOKLYN OBSERVATORY

Recently the Brooklyn College Observatory, which has a 7-inch Fecker refractor and a 3-inch transit, has become active in double star measurements, variable star observations, and astrophotography. A spectrograph is under construction.

A small group of students plans the observatory's activities. The public is invited to our open houses on Monday and Tuesday evenings.

PHILIP GOLDENBLATT
250 E. Gun Hill Rd.
Bronx 67, N. Y.

GRANTS PASS, OREGON

The Rogue Valley Astronomers and ATM's are currently increasing their membership by sponsoring public meetings and star parties. Last November about 120 persons attended an open house at which moon slides were shown and several telescopes displayed. A similar number were present at a star party last spring, held when Comet Arend-Roland was conspicuous in the evening sky.

The club's nine members have six reflecting telescopes, as well as a 2.4-inch refractor. Under construction are several 6-inch reflectors, a 10-inch rich-field telescope, and a 12½-inch Cassegrainian-Gregorian.

Further information may be obtained from Harvey Dickey, 1587 Fruitdale Rd., Grants Pass, Ore.

THIS MONTH'S MEETINGS

Geneva, Ill.: Fox Valley Astronomical Society, 8 p.m., Geneva City Hall. Feb. 18, Prof. Clarence R. Smith, "Instruments for Measuring Time."

Madison, Wisc.: Madison Astronomical Society, 8 p.m., Washburn Observatory. Feb. 12, Dr. Theodore E. Houck, Washburn Observatory, "Astronomical Observing Techniques."

New York, N. Y.: Amateur Astronomers Association, 8 p.m., American Museum of Natural History. Feb. 5, Dr. Martin Schwarzschild, Princeton University Observatory, "Astronomy from Skyhooks."

Plainfield, N. J.: Amateur Astronomers of Union County, 8 p.m., Stillman School auditorium. Feb. 21, symposium, "The Universe: Its Past, Present and Future."

St. Louis, Mo.: St. Louis Astronomical Society, 8 p.m., St. Louis Institute of Technology. Feb. 21, Robert J. Klaus, "Alexander von Humboldt, The Cosmos–Old and New Horizons."

Washington, D. C.: National Capital Astronomers, 8:15 p.m., Commerce Department auditorium. Feb. 1, astronomical motion pictures.

AMATEUR RADIO ASTRONOMY IN GREAT BRITAIN

Last February, the British Astronomical Association formed a new section for amateur research in radio astronomy and electronics. Work is already being done at wave lengths of three centimeters and one meter, and observations of radio noise from Jupiter have been published.

There are now about two dozen members of the section, according to the report of its director, J. Heywood, in the October issue of the BAA *Journal*. Some of these members are leaders of working groups; this method of organization is advantageous because of the cost and large size of most radio telescopes.

CARACAS, VENEZUELA

The Sociedad Astronomica de Venezuela was recently organized, with Francisco de Rosson as president. Correspondence from other amateur societies is invited by the secretary, J. M. D. Taracido, Este 15 No. 57, Caracas, Venezuela.

BALTIMORE, MARYLAND

Formed one year ago, the Martin Astronomical Society now has a membership of 150 scientists and engineers employed by the Martin Co., manufacturers of aircraft. Classes are held in basic astronomy and telescope making, and a radio telescope is planned. William R. Benton is curator of the group, which is limited to Martin personnel.

LISTING OF SOCIETIES

Here and There with Amateurs, a listing of all amateur groups that have registered with *Sky and Telescope,* is scheduled for this April's issue. Any changes in the previous listing, beginning on page 532 of the September, 1957, issue, should be sent to this magazine by February 15th. Clubs that were not listed there and whose membership is open to the public should write for a registration blank.

STELLAFANE 1958

The 1958 meeting of amateur telescope makers at Springfield, Vermont, will be held on Saturday, August 16th. Requests for information should be addressed to the Stellafane Committee, Amateur Telescope Makers of Boston, Harvard Observatory, Cambridge 38, Mass.

SALEM, OREGON

A group of 14 amateurs formed the Salem Astronomical Society last November. Officers of the club are B. W. Christensen, president; Mrs. Ray Strawn, vice-president; Mrs. Christensen, secretary; and Mrs. E. F. Breithaupt, treasurer. Interested persons should contact Mrs. B. W. Christensen, 1425 Marshall Dr., Salem, Ore.

ASTRONOMICAL SCRAPBOOK

(*Continued from page 180*)

lost at sea in a storm while passing between two local islands. After seventy days, it arrived on the Philippines island of Samar, 1,000 miles away, with a number of men, women, children, and babies, none of whom had any idea where they were."

One of Sharp's many arguments is the limited geographical knowledge of the islanders before European ships came. Often the dwellers on one atoll would be ignorant of the existence of other islands a few hundred miles away. A typical example of this involves islands currently of astronomical interest, because they are among the few land sites from which the October 12, 1958, total eclipse of the sun will be visible.

These are Atafu, Nukunono, and Fakaofo, in the northern Tokelau Islands (*Sky and Telescope,* October, 1957, page 573). When Horatio Hale visited these islands about the year 1840, he found them in communication with one another, but with no other islands. The inhabitants, however, knew of Pukapuka by name, for this was the next land to the east, from which the prevailing winds occasionally carried castaways.

Perhaps Sharp is right in believing that the colonization of the Pacific was effected more by chance than by long-range navigation. Even so, the peopling of this vast portion of the earth was a great human achievement.

JOSEPH ASHBROOK

OBSERVER'S PAGE

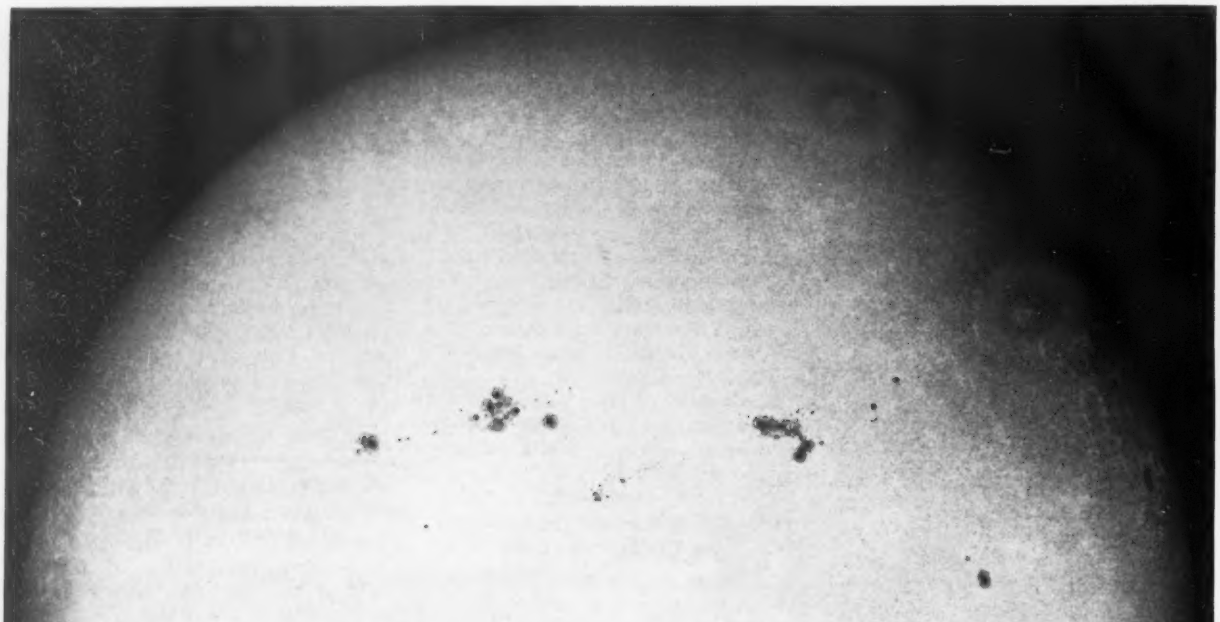
Universal time is used unless otherwise noted.

Amateur Observations of the Sun

LATE 1957 marked a new high in solar activity, the Zurich preliminary sunspot numbers averaging 263 in October, 207 in November, and 234 in December. There are many sunspots, large and small, and amateurs are finding that the changes on the sun's photosphere from day to day are easily observed with small telescopes. While a large aperture gives better resolution, the accompanying photographs show how well a small instrument reveals the major solar features.

In solar observing, collecting enough light is no problem – indeed, it is necessary to get rid of most of it to avoid injury to the observer's eyes. The so-called solar eyepiece furnished by manufacturers is not entirely safe, for though such a glass filter may be dark enough to reduce the sun's light properly, it is apt to crack in the intense heat collected at the instrument's focus. If one of these is used, the aperture of the telescope should be cut down to less than two inches.

An unaluminized mirror of moderate aperture (four or six inches) may be used together with a filter, according to Michael



Hans Arber, an active amateur astronomer in Manila, Philippine Islands, took this picture with his 6-inch refractor on December 25, 1957, at 01:03 UT, as part of his regular program of daily solar photography. It shows the sun about 1/25 of a rotation later than the view in Lewis Cook's sketch on the opposite page. South is at the top. On the date of this photograph, the Zurich provisional relative daily sunspot number was 357, very little below the year 1957's peak (366), which occurred the next day. Mr. Arber has described some of his techniques for solar photography in a letter on page 329 of the May, 1956, issue of "Sky and Telescope."

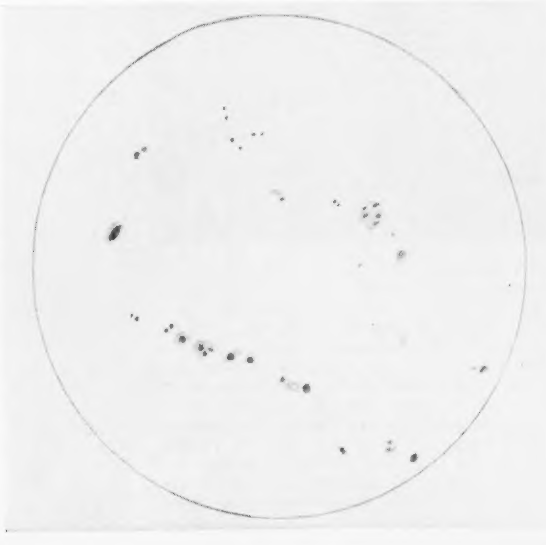
The sun on October 29, 1957, taken by Tony Woolner, New York City, when the day's sunspot number (350) was exceptionally high. This is one of a series of pictures, October 20-30, that he made to record the growth of sunspot groups.

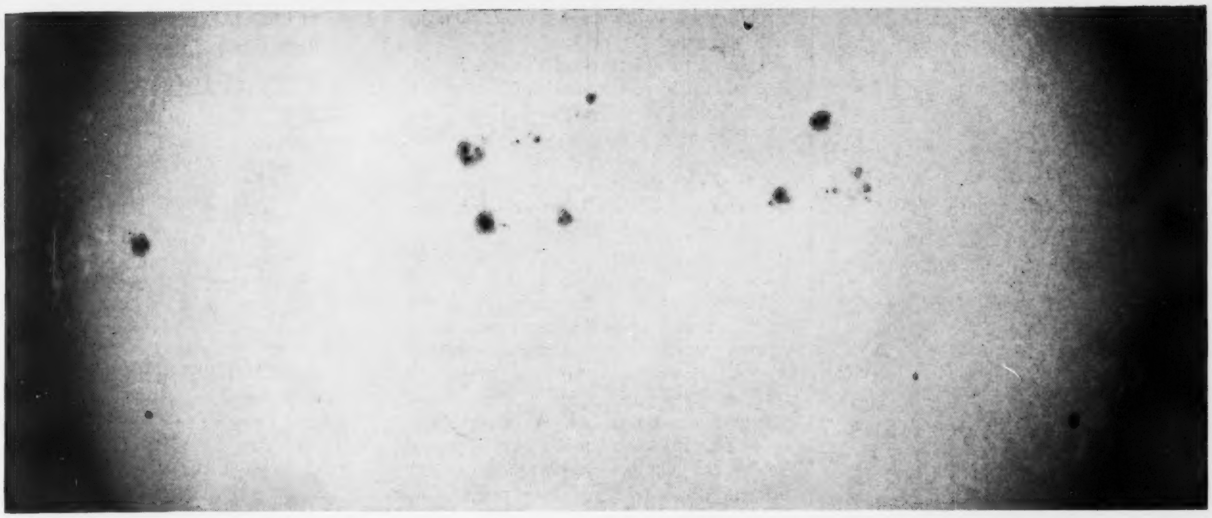
J. Morrow, Havertown, Pennsylvania. He finds that welder's-mask glass makes a good filter, through which the sun appears a deep yellow. The sunspots with their umbrae and penumbrae stand out quite dark by contrast. Many small-sized spots can be seen that go unnoticed with other filter systems.

For larger reflectors, the five per cent of incident light returned from the primary mirror may still be too strong, but if the secondary mirror or diagonal is likewise unaluminized, only 1/400 of the sun's light reaches the eyepiece.

With refractors, the effect of an unaluminized mirror can be achieved with a Herschel wedge, and the introduction of a second unsilvered diagonal (or prism turned with its hypotenuse toward the light) will then bring the final beam to

To make this drawing of the sun on December 23, 1957, at 22:15 UT, Lewis Cook, at Baton Rouge, Louisiana, employed a good method of observing sunspots that is very popular with many amateurs: projection through the eyepiece onto a clean white screen. The Zurich daily sunspot index number on this date was 330. To compare this drawing with Hans Arber's picture opposite, reverse left and right.





A father-and-son team, Philip and Robert Del Vecchio, of Paterson, New Jersey, took this photograph of the sun on April 28, 1957, at 15:30 UT. Notice the numerous sunspot groups; in each fully developed group, there is a large leading spot, with smaller following spots. On the original negative the solar image was two inches in diameter. Since December, 1956, the Del Vecchios have taken many solar photographs, often two or three a day. They are also making regular auroral observations for the International Geophysical Year.

1/400 the intensity of the original beam.

E. H. Noon, in the October, 1957, issue of the *Journal* of the British Astronomical Association (page 303), describes a simple projection box useful for sunspot observing with small telescopes. It is made from a tin can at least four inches in diameter and eight inches long. A hole is cut in the bottom just large enough to allow the threads of the eyepiece holder to pass through; when the latter is screwed onto the telescope it supports the device.

The lid of the can holds a clean white card on which the sun's image is focused. The viewing window is a two-inch square cut on the side of the can near the lid. If only three sides of the window piece are cut, it can be bent along the remaining side (toward the sun) to form a flap or shield that reduces the extraneous light falling on the card, for easier viewing.

An easily constructed viewer of this sort will enable one to see considerable detail in the spots if the telescope's lenses are clean and the telescope accurately focused. A more rigid assembly is, however, desirable for accurately diagraming the spots. Construction suggestions and detailed information on many phases of solar observing are given in the first chapter of *Ob-*

servational Astronomy for Amateurs, by J. B. Sidgwick (Macmillan).

Two of the pictures of the sun in this department were taken with Unitron 2.4-inch refractors. At New York City, Tony Woolner used a Crown Graphic camera body and an 18-mm. eyepiece to project the image to the focal plane. The exposure was 1/800 second, on Kodalith film, which has fine grain and is slow enough to control the exposure; it was developed in D-19 for less than a minute.

At Paterson, New Jersey, Philip J. Del Vecchio and his son Robert have made a camera attachment for their refractor, stopped down to $1\frac{3}{4}$ inches, projecting through an eyepiece for a solar image diameter of two inches. A Zeiss yellow-green or a Rollei green X-1 filter is placed behind the eyepiece. Exposures on Kodak fine-grain, positive, cut film range from 1/50 to 1/125 second, with Ethol UFG used for development. Mr. Del Vecchio and his son are members of the AAVSO and participate in its Solar Division program.

Hans Arber's picture, enlarged from a 5-by-7 negative, was taken last Christmas Day, with a 6-inch Unitron refractor, a 50-mm. projection lens, and an orange filter. Kodalith cut film was developed in D-11, diluted one to eight, for 10 minutes. Mr. Arber considers this one of the very best pictures he has ever obtained during two years of daily photography of the sun.

Lewis Cook, a 12-year-old amateur at Baton Rouge, Louisiana, used the projection method with his 3-inch reflector when he drew the sketch on page 185, made on December 23rd, at 22:15 Universal time.

SUNSPOT NUMBERS

These are observed mean relative sunspot numbers from Zurich Observatory and its stations in Locarno and Arosa.

November 1, 265; **2,** 256; **3,** 230; **4,** 210; **5,** 200; **6,** 180; **7,** 175; **8,** 155; **9,** 190; **10,** 230; **11,** 224; **12,** 220; **13,** 185; **14,** 180; **15,** 177; **16,** 180; **17,** 191; **18,** 225; **19,** 183; **20,** 208; **21,** 235; **22,** 275; **23,** 250; **24,** 236; **25,** 200; **26,** 198; **27,** 171; **28,** 235; **29,** 192; **30,** 162. Mean for November, 207.3.

December 1, 216; **2,** 206; **3,** 218; **4,** 225; **5,** 258; **6,** 220; **7,** 164; **8,** 187; **9,** 137; **10,** 143; **11,** 150; **12,** 153; **13,** 155; **14,** 164; **15,** 170; **16,** 189; **17,** 205; **18,** 227; **19,** 249; **20,** 284; **21,** 298; **22,** 302; **23,** 330; **24,** 345; **25,** 357; **26,** 366; **27,** 269; **28,** 260; **29,** 275; **30,** 274; **31,** 255. Mean for December, 233.9.

The following American sunspot numbers for November were derived by Dr. Sarah J. Hill, of Whitin Observatory, Wellesley College, from AAVSO Solar Division observations.

November 1, 241; **2,** 234; **3,** 198; **4,** 243; **5,** 200; **6,** 202; **7,** 167; **8,** 170; **9,** 214; **10,** 229; **11,** 208; **12,** 199; **13,** 199; **14,** 191; **15,** 176; **16,** 164; **17,** 150; **18,** 148; **19,** 157; **20,** 165; **21,** 188; **22,** 235; **23,** 226; **24,** 190; **25,** 163; **26,** 132; **27,** 173; **28,** 196; **29,** 180; **30,** 201. Mean for November, 191.3.

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3¼" diam., 48" f.l. (uncoated)	**$28.00**	4⅛" diam., 62" f.l. (uncoated)	**$60.00**
Same as above with coating	**$32.00**	Same as above with coating	**$69.00**

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Diameter	Focal Length	Each	Diameter	Focal Length	Each
54 mm (2⅛")	254 mm (10")	$12.50	83 mm (3¼")	660 mm (26")	$28.00
54 mm (2⅛")	300 mm (11.8")	12.50	83 mm (3¼")	711 mm (28")	28.00
54 mm (2⅛")	330 mm (13")	12.50	83 mm (3¼")	762 mm (30")	28.00
54 mm (2⅛")	390 mm (15.4")	9.75	83 mm (3¼")	876 mm (34½")	28.00
54 mm (2⅛")	508 mm (20")	12.50	83 mm (3¼")	1016 mm (40")	30.00
54 mm (2⅛")	600 mm (23½")	12.50	102 mm (4")	876 mm (34½")	60.00
54 mm (2⅛")	762 mm (30")	12.50	108 mm (4¼")	914 mm (36")	60.00
54 mm (2⅛")	1016 mm (40")	12.50	110 mm (4⅜")*	1069 mm (42-1/16")	60.00
54 mm (2⅛")	1270 mm (50")	12.50	110 mm (4⅜")	1069 mm (42-1/16")	67.00
78 mm (3-1/16")	381 mm (15")	21.00	128 mm (5-1/16")*	628 mm (24¾")	75.00
80 mm (3⅛")	495 mm (19½")	28.00	128 mm (5-1/16")	628 mm (24¾")	85.00
81 mm (3-3/16")	622 mm (24½")	22.50	*Not coated		

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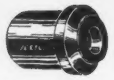

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F.L.	TYPE	PRICE
12.5 mm (½")	Symmetrical	$ 6.00
16 mm (⅝")	Erfle (wide angle)	12.50
16 mm (⅝")	Triplet	12.50
18 mm (¾")	Symmetrical	6.00
22 mm (27/32")	Kellner	6.00
32 mm (1¼")	Orthoscopic	12.50
35 mm (1⅜")	Symmetrical	8.00
55 mm (2-3/16")	Kellner	6.00
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Plate Glass	3-3/16"	42"	$ 9.75
Pyrex	4¼"	45"	13.50
Pyrex	6"	60"	25.00

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Cast aluminum. Holds all our mirrors firmly with metal clips. Completely adjustable. Assembled, ready to use.

3-3/16"	Mount fits our 4½" tubing	$4.00 ppd.
4¼"	Mount fits our 5" tubing	4.00 ppd.
6"	Mount fits our 7" tubing	7.00 ppd.

Aluminum Telescope Tubing

O.D.	I.D.	Price Per Ft.
2¼"	2⅛"	$1.20 ppd.
3⅜"	3¼"	1.75 ppd.
4½"	4⅜"	2.75 ppd.
5"	4⅞"	2.75 ppd.
7"	6⅞"	3.00 f.o.b.

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The aluminum body casting is finished in black crackle paint and is machined to fit all our aluminum tubing. Has a chrome-plated brass focusing tube, which accommodates standard 1¼" eyepieces.

For 2⅛" I.D. Tubing	Postpaid	$12.95
For 3¼" I.D. Tubing	"	12.95
For 4⅜" I.D. Tubing	"	12.95

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Cell for Lenses	Cell Fits Tubing	Price
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78 mm "	3¼" "	6.50
81 mm "	3¼" "	6.50
83 mm "	3¼" "	6.50
110 mm "	4⅜" "	10.50

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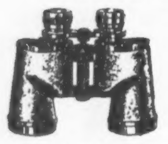

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SIZE	TYPE	C. FOCUS	IND. FOCUS
6 x 15	OPERA	—	$12.75
6 x 30	"ZEISS"	$18.75	16.75
7 x 35	"ZEISS"	21.25	19.25
7 x 35	AMERICAN	23.50	—
7 x 35	AMERICAN WIDE ANGLE 10°	37.50	—
7 x 50	"ZEISS"	24.95	22.50
7 x 50	AMERICAN	32.50	—
8 x 30	"ZEISS"	21.00	18.25
10 x 50	"ZEISS"	30.75	28.50
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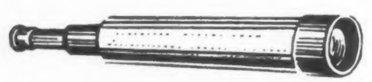

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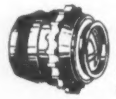

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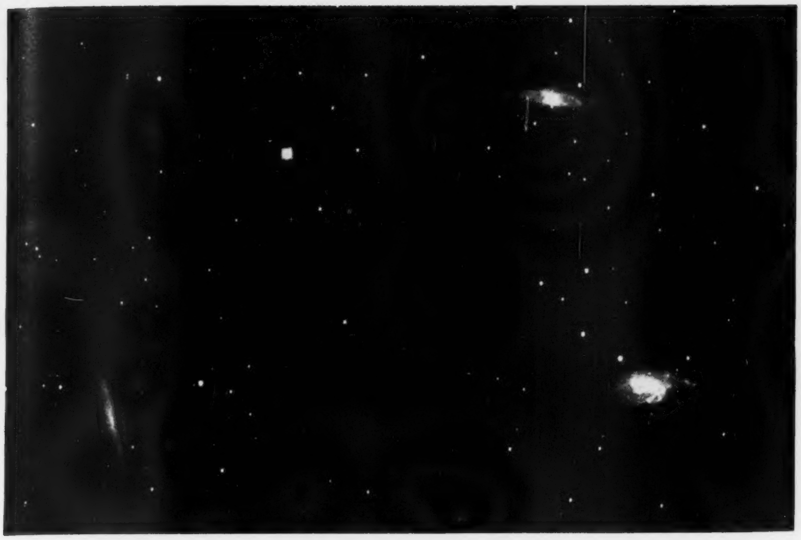

Three galaxies with the same Hubble classification, Sb, but with quite differing appearances in amateur telescopes, are these found within a small area south of Theta Leonis. M65 is at top right, M66 at lower right, and NGC 3628 in the lower left corner; north is toward the left, west, the top. Dr. Clarence P. Custer, Stockton, California, took this $2\frac{1}{4}$-hour exposure on March 23, 1955, with the prime-focus camera on his $12\frac{1}{2}$-inch Springfield reflector. His camera is described in Gleanings for ATM's in the January issue and on page 201 of this issue.

DEEP-SKY WONDERS

TUCKED under the "triangle" of eastern Leo, yet passed over with slight mention by most handbooks, lie three galaxies so close together that some telescopes will show them in the same low-power field. Reproduced here is Dr. Clarence P. Custer's photograph of them, which awakened memories, for I had not looked at them for years.

Messier 65, westernmost of the two brighter galaxies, is located at right ascension $11^h\ 16^m.3$, declination $+13°\ 23'$ (1950.0). This is a lenticular object measuring $8'$ by $2'$, of visual magnitude 8.9 according to Holetschek, while Gingerich assigns 10. Also known as NGC 3623, it is a spiral galaxy of type Sb. The Custer $12\frac{1}{2}$-inch photograph shows distinctly the faint arm extending to the south. Visually, with my 10-inch reflector and a fine sky, this arm was only suspected, and probably not seen at all. For a more detailed view of the delicate arm structure, the reader may consult the beautiful old photograph in Lick Observatory *Publications*, Vol. 8, Plate 28.

Also an Sb galaxy but with a more irregular and curdled appearance is Messier 66 (NGC 3627), at $11^h\ 17^m.6$, $+13°\ 17'$. Its published dimensions are $8'$ by $2'.5$, and the visual magnitude is 8.6 (Holetschek) or 9 (Gingerich). Compared with M65 in my 10-inch, M66 is hardly recognizable as a spiral, resembling a stray diffuse nebula, but photographs prove otherwise.

Largest of the three, and apparently a little too faint for Messier's telescopes, is NGC 3628, at $11^h\ 17^m.7$, $+13°\ 53'$. It is also an Sb galaxy, $12'$ by $1'.5$ in extent. Holetschek called its visual magnitude 10.2, while the photographic value is 11.3. Conspicuous in the photograph is the dark lengthwise band of obscuring matter that seems to divide this object in two. With the 10-inch this dark band was dimly but certainly seen; it might serve as an indicator of seeing conditions.

Indeed, these three galaxies, so conveniently located, can be used for tests of visual magnitude estimates, and I would welcome a post card from anyone who makes an intercomparison of the three objects in terms of tenths of a magnitude. Post cards are requested because they can be filed without being recopied onto other cards.

WALTER SCOTT HOUSTON
Rte. 3, Manhattan, Kans.

OBSERVING HERSCHEL OBJECTS

Amateur astronomers who have located all the nebulae and clusters in Messier's catalogue form a world-wide if unorganized "Messier Club." Two such observers, Tom Noseworthy and Dr. T. F. Morris of the Royal Astronomical Society of Canada, have started an even larger project — observing as many as possible of William Herschel's objects.

Herschel's lists of nebulae and clusters divide them into eight classes: I, bright nebulae; II, faint nebulae; III, very faint nebulae; IV, planetary nebulae; V, very large nebulae; VI, very compressed and rich clusters of stars; VII, compressed clusters of bright and faint stars; and VIII, coarse, loose star clusters. Objects are numbered serially with each class; thus IV 1 is the Saturn nebula in Aquarius. Norton's *Star Atlas* is especially helpful in finding the Herschel nebulae and clusters, labeling them by number and class.

How To Make Use of Universal Time

PREDICTIONS for events listed in *Sky and Telescope's* Celestial Calendar and Observer's Page are given in Universal time (UT), unless otherwise stated. This is local time at Greenwich, England, through which the zero meridian of longitude passes, and is counted on a 24-hour basis, from midnight (0:00) to midnight (24:00).

Universal time is easily converted to clock time in the United States by subtracting the number of hours corresponding to the longitude of the standard-time meridian. Since the earth turns 360 degrees in 24 hours, 15 degrees of longitude equal one hour of time. Thus, to obtain the corresponding Eastern standard time (EST), which is based on longitude 75° west, subtract 5:00 from the UT figure. Similarly, for another standard-time zone, subtract the difference given in the table:

Zone	*Time*	*Meridian*	*Difference*
Eastern	EST	75° W.	5:00
Central	CST	90° W.	6:00
Mountain	MST	105° W.	7:00
Pacific	PST	120° W.	8:00

Suppose, for example, you live in Pennsylvania, and wish to know just when this month's first-quarter moon will occur. In the Celestial Calendar, this event is listed at 20:51 UT on February 26th. Since Pennsylvania is in the Eastern standard-time zone, subtract five hours, obtaining 15:51 for standard time on the 24-hour clock. Subtract another 12 hours to change this into time kept by 12-hour clocks, which gives 3:51 p.m. EST on February 26th as the moment of first quarter.

Sometimes the conversion from Universal time requires a change of date. This is the case whenever the correction for the difference in longitude is numerically larger than the UT that is being converted to standard time. Then 24:00 must be added to the UT before the subtraction is made, and the event occurs a day earlier than the Greenwich date. Generally speaking, if an event happens early on a particular day at Greenwich, it will, at that moment, be late on the preceding day in the United States.

The foregoing paragraph is illustrated by picturing someone in San Francisco wanting to listen to the Zurich Observatory broadcast of sunspot numbers at 4:20 UT on February 5th. (The broadcast schedule was given on page 138 of the January issue.) Since the eight-hour correction to Pacific standard time amounts to more than the time to be converted, the Universal time must be expressed as 28:20 before the subtraction is made. The result is 20:20 PST, or 8:20 p.m. PST on February 4th.

When daylight-saving time is in use, subtract one hour *less* from the UT to get the corresponding clock time. The time-zone corrections then become: EDT, 4:00; CDT, 5:00; MDT, 6:00; PDT, 7:00.

To express zone time as Universal time, simply reverse the process, adding the correction instead of subtracting it. Suppose that an observer in Chicago sees a bright meteor on February 10th at 9:10 p.m. CST. To convert this to Universal time, first change it to 24-hour time by adding 12 hours, giving 21:10 CST. Then add 6:00 to convert to UT, giving 27:10 UT. This corresponds to 3:10 UT on the following day, February 11th, which is the Universal time of the meteor observation.

In reporting the time of any observation, *always* specify whether it is UT, EST, or some other kind of time. Without this information, an important record may lose much of its value.

BOOKS AND THE SKY

AN INTRODUCTION TO ASTRONOMY

Robert H. Baker. D. Van Nostrand Co., Inc., Princeton, N. J., 1957. 333 pages. $4.85.

A FAVORITE since its first publication in 1935, this standard introductory text has been thoroughly rewritten, with some rearrangement of material and the incorporation of recent discoveries and newest interpretations. In this fifth edition, the author has not merely added a paragraph here and there, but has rewritten the older sections so that the whole reads along in a smooth and connected fashion.

One of the major changes was in deferring the study of constellations from chapter 5 to 11, between chapter 10 ("The Sun with Its Spots") and chapter 12 ("The Stars Around Us"). The reviewer fails to grasp this rearrangement as an advantage, and feels that the list of constellation names, the magnitude scale, and the Greek alphabet should not have been omitted in the revision.

The chapter on eclipses in the earlier edition has been broken into two parts, lunar eclipses being taken up at the end of the chapter on the moon, the solar at the end of the sun chapter. Again one fails to see the advantage of this arrangement over discussing the two types of eclipses together.

Chapter 14 is devoted to star clusters, in keeping with their increased importance, and is an improvement over the few pages given to them in the preceding edition.

Dr. Baker has included and utilized significant findings with the 200-inch Hale telescope, showing how these permitted a recalibration of the period-luminosity relation for Cepheid variables. This resulted in enlarging the scale of distances to other galaxies, their actual sizes being increased in the same proportion as their distances; our own Milky Way galaxy is no longer considered the largest. He tells in his clear fashion how we trace the spiral arms of our galaxy by three means: direct photography of bright nebulae and of the kinds of stars that are also found in the arms of exterior spirals; radio reception from the hydrogen in dark gas clouds (21-cm. emission); and interstellar lines in the spectra of stars.

Considerable attention is given to the findings of radio telescopes. The author devotes several pages to current ideas about the origin of the solar system and recounts the new and stirring adventures in thinking about cosmic evolution. McLaughlin's map and recent suggested explanation of the dark markings on Mars are included. A separate subsection on page 78 about the advantages of a large telescope is a welcome addition for the beginning student.

Graphs and tables have been brought as nearly up to date as possible. Predictions of future events, such as eclipses and planet positions for some years ahead, have been inserted. References for further reading, formerly in one list at the end of the book, are now more conveniently placed after individual chapters, along with the review questions.

A few minor changes might be suggested. The present decimal system used in referring to paragraphs is annoying and time-consuming; references should be made by page number, and diagrams should be numbered consecutively. The figure on page 53, carried over from the former edition, would explain sidereal time more clearly if the north celestial pole were added. The map of the moon on page 99, likewise from the other volume, is not complete enough for the identification of lunar features. The discussion of the Schmidt telescope, page 76, would be improved by a diagram showing the path of rays of light through the instrument, like the diagrams for refractors and reflectors in the same chapter.

Typographical errors are at a minimum. The book retains its excellent format, while larger type makes for easier reading without changing the convenient size of the volume. The quality of the paper and reproductions of photographs maintain previous high standards. Topics are so ordered that, in general, the college teacher may readily plan his course and base his lectures upon them.

The time and effort spent by Dr. Baker on this revision enhance its high value both as a text and as a reference book on general astronomy.

HAZEL M. LOSH
University of Michigan Observatory

PRACTICAL ASTRONOMY

W. Schroeder. The Philosophical Library, New York, 1957. 206 pages. $6.00.

AMATEURS, for whom this book is intended, will understand that the first word of the title means essentially "do it yourself." This word is not used in quite the same sense as in the professional astronomer's term *practical astronomy*.

Stressing graphical methods for solving astronomical observing problems, this book goes as far in this direction as possible without spherical trigonometry. The title of the second chapter, "From the Stargazer's A B C," indicates the basic approach used to introduce astronomy to the novice. The constellations are illustrated with excellent diagrams. Telling time by the stars comes early, setting the mood for the applications to follow. The treatment of local sidereal time is particularly good.

Time, latitude, and longitude are then discussed, and directions are given for the geometrical constructions necessary in

making good sundials, as well as for a quadrant. The author states that his simple methods enable anyone to determine his position on the earth's surface to within about six miles. Next follows "Solving Problems," by means of celestial globe and astrolabe (the latter a surprisingly versatile instrument). Graphical solutions of the astronomical triangle are also described.

One section of the book particularly caught this reviewer's fancy. It concerns graphical determination of the positions of the planets and the moon in the sky with an accuracy of about $\frac{1}{4}$ degree. It tells how to predict eclipses of the moon, and how to construct an astronomical calendar similar to the Graphic Time Table of the Heavens (see January *Sky and Telescope*). For this, all one needs besides this book is a pencil and plenty of paper.

The book closes with an extensive description of the more interesting objects that can be observed with the naked eye or very slight optical aid.

Mr. Schroeder, a member of the British Astronomical Association, is very careful, and no mistakes were detected. Some of the terms used are a little odd, but should give no real difficulty. The writing tends to be a bit dry in spots, and the light curves for variable stars are somewhat oversimplified.

Certainly a good book for the beginner, its contents should also be of value to the advanced amateur who wants to solve observing problems himself.

W. E. S.

A KEY TO THE STARS

R. van der Riet Woolley. The Philosophical Library, New York, 1957. 144 pages. $4.75.

WRITTEN for the general reader, this book concerns the elementary aspects of astronomy and presupposes no special background in physics and mathematics. Within these limitations, the author deals ably with the classical problems of positional astronomy, celestial mechanics, and astrophysics. He describes in outline the solar system, our galaxy, and other stellar systems. Greenwich, Mount Wilson, Lick, Palomar, and a few other observatories are discussed briefly.

Although this is not a textbook, there is a surprising amount of standard information in its 144 pages. The subjects of the seven essay chapters are: time and longitude, the solar system, stellar distances and magnitudes, the temperature of the stars, the composition of the stars, the galaxy, and the world's observatories. While serving as an excellent introduction for beginners, the book might be even more useful as a refresher for those who seek a quick review of the field. It gives considerable historical insight into how present scientific concepts have evolved.

While it is hard to find fault with this admirable little book, it may be that in its third edition the work should have been enlarged to include more than the "fundamentals" of astronomy. Human needs and interests change, and modern readers might like, for example, more than a paragraph on meteors and two on comets. They would also be interested in a discussion of such topics as earth satellites, the atmosphere of the earth, the surface of the moon, radio telescopes, the IGY program, amateur societies, and government financing of science, especially since the author is the Astronomer Royal of England.

RALPH S. BATES
State Teachers College
Bridgewater, Mass.

NEW BOOKS RECEIVED

Constructing an Astronomical Telescope, *G. Matthewson,* 1957, *Philosophical Library.* 100 pages. $3.00.

In this second, enlarged edition of a book first published in 1947, the beginner learns how to make an inexpensive reflecting telescope. Brief instructions, with many drawings, are given for grinding, figuring, testing, and mounting the mirror.

The Planet Earth, edited by *Scientific American,* 1957, *Simon and Schuster.* 168 pages. $1.45, paper bound.

In these 14 reprinted magazine articles, professional scientists write on a popular level about the origin of the earth; its interior, heat, and magnetism; the shape of the earth, its surface, glaciers, and oceans; the atmosphere and beyond; and there is a brief explanation of the launching and orbits of artificial satellites.

The Universe, edited by *Scientific American,* 1957, *Simon and Schuster.* 142 pages. $1.45, paper bound.

Well-known astronomers, physicists, and a historian of science wrote these 11 articles. They summarize, in a moderately popular style, man's study of the universe; the origin of the elements; the galaxies; theories about the structure of the universe; and studies of the red shift, the distribution of galaxies, and radio galaxies.

And There Was Light, *Rudolf Thiel,* 1957, *Knopf.* 415 pages. $6.95.

In nontechnical language, translated from the German by Richard and Clara Winston, the author traces the growth of astronomy from the earliest ideas of space up to modern instruments and theories about the universe.

Die Sonnenkorona, Volume II, Struktur und Variationen der Monochromatischen Korona, *M. Waldmeier,* 1957, *Birkhäuser Verlag,* Basel, Switzerland. 353 pages. 68.50 Swiss francs.

Professor Waldmeier published the first volume of *Die Sonnenkorona* in 1951, reporting observations of the solar corona during 1939-1949. Volume II is a detailed analysis of the structure and variations in the corona, as observed in the light of its red, green, and yellow spectrum lines. This technical account in German contains much tabular data and numerous maps of the corona.

Introduction to the Mechanics of Stellar Systems, *Rudolf Kurth,* 1957, *Pergamon.* 174 pages. $9.00.

The author, who is on the staff of the astronomy department of the University of Manchester, develops mathematical methods that can be applied to theoretical investigations of stability and internal motion in galaxies, star clusters, and nebulae. Stellar systems are first considered as assemblies of mass points, and then as gravitating continua. The work is highly technical in character, and is intended for specialists and advanced students. The book was translated from the German by F. D. Kahn.

The Planet Venus, *Patrick Moore,* 1957, *Macmillan.* 132 pages. $3.00.

Patrick Moore, director of the Mercury and Venus section of the British Astronomical Association, has written this book devoted entirely to Venus, summarizing 350 years of observational evidence and conflicting theories concerning the planet's nature.

The Stars Above Us, *Ernst Zinner,* 1957, *Scribner's.* 141 pages. $3.00.

The author is the former director of the Remeis Observatory in Bavaria, and a widely known historian of astronomy. He presents a popular account of how the growth of astronomy over the ages has been accompanied by the development of religious practices, folklore, astrology, and strange beliefs. Examples are drawn from all parts of the world. The translation is by W. H. Johnston.

The Handbook of the British Astronomical Association 1958, *J. G. Porter,* editor, 1957, *British Astronomical Association,* 303 Bath Rd., Hounslow West, Middlesex, England. 64 pages. 5s for members; 9s for nonmembers; paper bound.

Designed for the serious amateur, the BAA *Handbook* is a great aid in planning and carrying out an observing program. It contains ephemerides of the sun, moon, planets, and of the periodic comets expected to return this year. Finder charts for the three outermost planets are given, as well as predictions of phenomena of Jupiter's satellites and information for identifying the moons of Saturn. A useful feature for lunar observers is a table giving the sun's colongitude for each day.

Cosmic View: The Universe in 40 Jumps, *Kees Boeke,* 1957, *John Day.* 48 pages. $3.25.

This book of pictures with text takes the reader on a journey through the universe, to the edge of infinity in one direction and to the nucleus of the atom in the other.

The Planet Earth, *D. R. Bates,* editor, 1957, *Pergamon Press,* 4 and 5 Fitzroy Sq., London W. 1, England. 312 pages. 35s.

Fifteen authors, in the 17 articles of this book, provide the general reader a background in geophysics, to enable him to understand and follow the work of the International Geophysical Year.

Once Round the Sun, *Ronald Fraser,* 1957, *Macmillan.* 160 pages. $3.95.

"The Story of the International Geophysical Year" is the subtitle of Dr. Fraser's book, which is a well-rounded, illustrated, popular account of this great scientific effort. Its chapters range from antarctic exploration to artificial satellites.

How To Make a Telescope, *Jean Texereau,* 1957, *Interscience.* 191 pages. $3.50.

The president of the committee on instruments of the Astronomical Society of France describes for the serious amateur the construction of an 8-inch Newtonian reflector. The book, which appeared as a series of articles in *l'Astronomie,* was translated into English by Allen Strickler.

Geography in the Twentieth Century, *Griffith Taylor,* editor, 1957, *Philosophical Library.* 674 pages. $10.00.

Mature students of geography will find many aspects of the subject covered in this book, including the historical, regional, economic, and sociological. Two chapters deal with meteorology and one with the interpretation of aerial photographs.

This third edition, enlarged and revised, contains the work of 23 authors from the United States, England, Canada, Czechoslovakia, and Poland. Included is a new chapter by the editor on geopolitics and geopacifics. A glossary of 700 geographical terms concludes the volume.


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See the back cover.

GLEANINGS FOR ATM's

CONDUCTED BY ROBERT E. COX

A PRIME-FOCUS CAMERA FOR A LARGE AMATEUR REFLECTOR — II

LAST MONTH we discussed some of the features of the camera I use with my 12½-inch Springfield reflector. The position of the camera within the telescope was shown, and details were given of the focusing cylinder, supporting plate and shutter, and the base-plate and carrier assembly. This month we will examine the optical field-viewing and focusing device, and the system for guiding on a star.

A prism-and-lens assembly is fitted over the hole in the top of the last carrier plate to make the optical field-viewing device and for focusing the camera (Fig. 7). The parts are shown in Fig. 8, beginning at the top with the cover for the 1¼" right-angle prism below it. The triangular objects near the prism are cardboard separators used for fitting the prism in the cover and on the housing. The main body of this housing is the right-angled affair seen just below the prism. Although only one tubular extension is visible in the picture, there is also a shorter one, extending below the lower plate, which fits snugly into the hole in the upper plate of the carrier. The end of this lower tube is threaded, and at the left in Fig. 8 are the collar, locking ring, and spanner wrench used to tighten the tube to the carrier assembly once the prism is placed correctly.

Below the prism assembly is the adapter tube for the field-viewing and focusing lenses, which are achromats 26 millimeters in diameter, having a focal length of 105 millimeters. The first lens is inserted with its crown side away from the prism, then a spacer ring is put in, and the second lens is placed with its crown side toward the prism. The assembly is firmly held together by the retaining ring and the adjustable clamp. When positioned properly, this optical train projects part of the telescope's image from the focal plane through the prism to a new focus 7½" away at the side of the tube. Here the image can be examined with a 1¼" giant Erfle eyepiece.

The only remaining piece of equipment is the optical system for guiding on a star just outside the area of the plate. In Fig. 9 are the guide telescope and the apparatus with which it is controlled. Angle brackets fasten the carrying track

Left: Fig. 7. Here the field-viewing device is seen mounted on the sliding carrier assembly.

Below: Fig. 8. The principal parts of the field-viewing device.

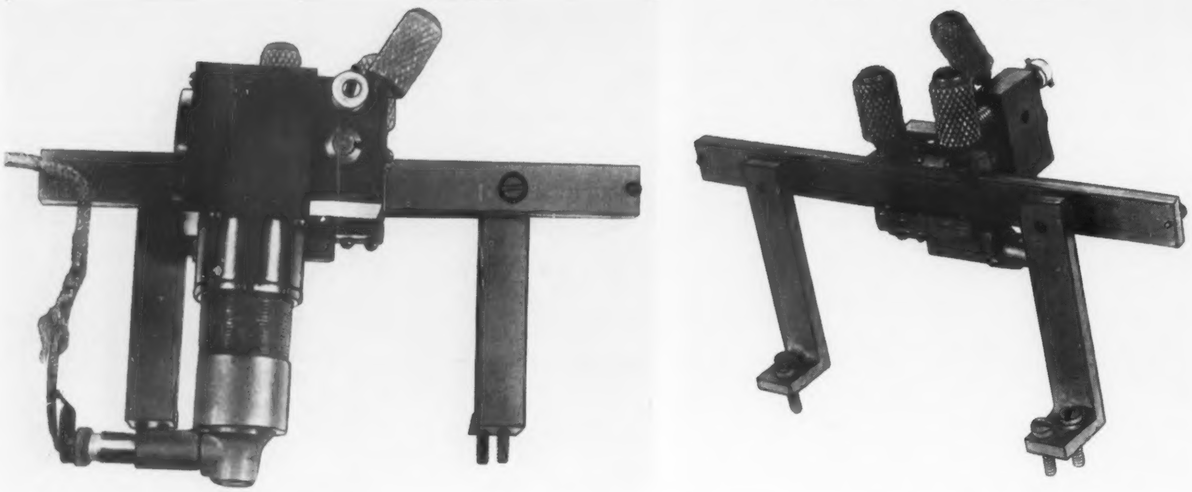


Fig. 9. The assembled guiding telescope is shown at the left. The small bulb extending from the bottom of the unit illuminates a reticle which is located in the focal plane of the 12½-inch mirror. At the right are seen the sliding rack and the knurled locking thumb screws that clamp the system after a guide star has been found; here, the guide telescope is not shown.

to the top plate of the carrier system. The guide-telescope assembly is moved toward and away from the observer by sliding it along the track. When a suitable star has been found, one tightens the two vertical, knurled, locking thumb screws seen just over the track in the right-hand picture. Just behind the right locking screw is the block that carries the optical train, and the hole in the face of the block is for fastening the prism housing to the sliding assembly.

If no suitable object for guiding can be located along the track, the block is moved across the observer's line of sight by means of the screw that runs horizontally through it. The screw head is slotted to receive a control rod inserted from the side of the telescope tube (upper right in Fig. 11). A keyed post just below the screw keeps the block running true. If this second adjustment of the guide-telescope position is needed, then the third knurled screw extending at an angle from the back of the block must be loosened, then retightened.

In the left-hand picture of Fig. 9, the large box contains a ½″ prism, and in the extensions below it are mounted field lenses and the guiding reticle. The lenses are cut down to 10.4 millimeters from an 18-millimeter symmetrical eyepiece set of ¾″ focus, and are placed to pick up the light of a star image in the primary focal plane and send it in a parallel beam to the side of the main tube. There a coated achromatic lens, diameter 1¾″, focal length 7.44″, brings the rays to a focus before a 1¼″ giant Erfle eyepiece. A Mark 15 reticle was cut down from its original 11 millimeters to 3/16″, and is mounted so as to be in the focal plane of the paraboloid, as it was easier to place it here and eliminate parallax while guiding. The extension at the left carries a Bausch and Lomb ophthalmoscope globe, a 2.5-volt bulb that illuminates the reticle. This is a long-life bulb quite suited to this task.

In Fig. 10, the completely assembled prime-focus camera is shown, as seen from in front of the field-viewing and guide telescopes. The latter's objective, with its associated reticle and right-angle prism, is pictured at the limit of its motion away from the plateholder. The bulb holder for illuminating the reticle was removed for this photograph. The various plates that make up the carriers of the camera

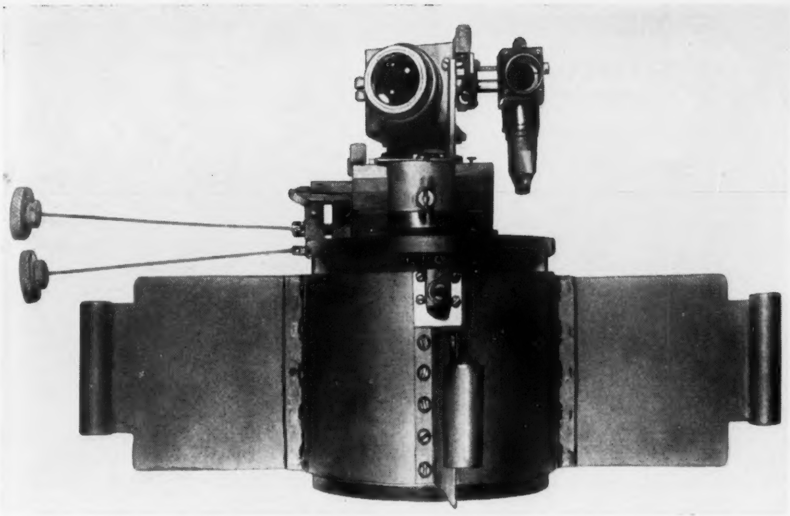


Fig. 10. The assembled prime-focus camera as it appears before insertion in the telescope tube. The photographs with this article were selected from a set prepared by the author to illustrate all the camera's components.

may also be seen. The slotted screw at the top of the wall of the outer cylinder is the one used for focusing the camera (Fig. 3, page 150, January issue).

Two control rods extend toward the left from the plate carrier. The top one is for moving the plateholder laterally across the observer's line of sight. The rod directly below this one is the control for the hinged shutter.

Fig. 11 is a view of the outside of the telescope's main tube as it appears when ready to take a picture. The longer of the two black tubes, optically like a MOONWATCH telescope, carries the guiding eyepiece; to its left is the focusing and field-viewing eyepiece. The black cord beneath the eyepieces carries current to the bulb for the guiding reticle. The uppermost knob beneath the two eyepieces controls the plate motion toward and away from the observer; the lower knob is for focusing. The knob a quarter of the way around the tube toward the right is for controlling motion of the guiding telescope across the line of sight.

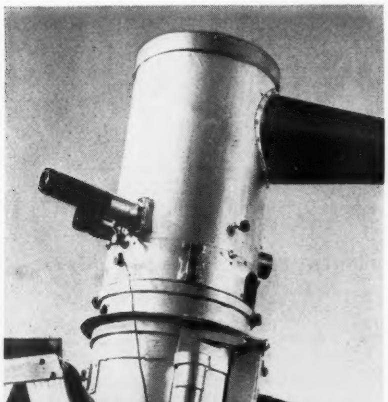


Fig. 11. The upper part of the Custer reflector, ready for photography.

The opening on the right side of the telescope is for placing and removing the plateholder, for clamping the guide telescope, and for other manual operations inside the tube. The narrow two-piece band clamp running around the tube at the bottom of this opening supports the bolts inside the tube onto which are fastened the camera's spider vanes. The wider band, in which the large hole has been cut, and which extends to the base of the eyepiece assembly, provides for eight spider arms (wire) of a support for a diagonal $1\frac{1}{3}''$ wide, when the instrument is used visually as a Newtonian for fine planetary detail.

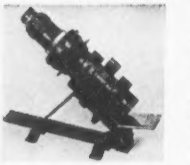
One of the two elbow telescopes that are used as low-power finders is visible in the lower center part of the picture, just to the left of the electrical control panel at the back of the polar-axle housing. On the ladder is a microswitch control box for guiding in right ascension.

This concludes the description of the construction of my prime-focus camera. In another department in a forthcoming issue of *Sky and Telescope*, the photographic technique necessary for operating the device and the results obtained with it will be discussed.

An example of the space penetration possible with my long-focus telescope, using the prime-focus camera, is seen in the present issue on page 191 — an enlargement of a $2\frac{1}{4}$-hour exposure on a field of three bright galaxies in Leo.

CLARENCE P. CUSTER, M.D.
155 E. Sonoma Ave.
Stockton, Calif.

WAR-SURPLUS "SATELLITER" MOUNT



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Adjustable through about 75° angle. Tube has spring-shock mounting. Also can be mounted and used vertically. Made of light-weight aluminum and magnesium.

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Declination circle has 360° divided into 1° blocks, and reads from 0 to 90 to 0 to 90 to 0.

Right-ascension circle has 24-hour scale divided into 5-minute blocks with two different scales on the same side. One reads from 0 to 6 to 0 to 6 to 0 hours and the other 0 to 24 hours consecutively. Instruction sheet included.

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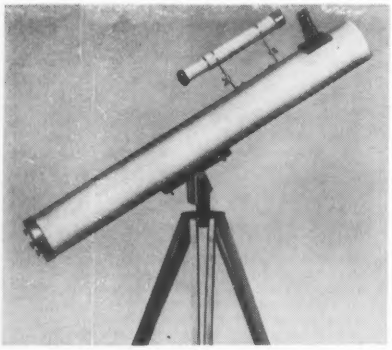

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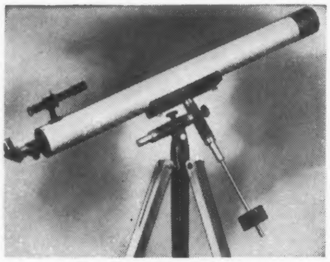

Complete with Finder, Equatorial Mounting, Tripod, Eyepiece Extension, Star Diagonal, and Three Eyepieces

A fine instrument, designed for rugged use and quality performance. Mounting made from heavy iron castings with machined bearings for smooth operation. Tripod has extra-heavy 60" hardwood legs. Telescope's weight is 42 lbs., giving stable, steady viewing. Big 4" objective is an air-spaced achromat, each element coated on both sides for low reflection. Three eyepieces supplied give you 48X, 120X, and 240X. Special Barlow lens also gives up to 500X. Star diagonal included for comfortable viewing at high angles. Rack-and-pinion focusing. All metal parts are plated to prevent rusting. Finder is 8 power. The usual price for a 4" refractor of comparable quality is over $400, so our model saves you almost 40%.

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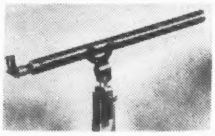

Here is a nice refractor for the beginner. Has a fine, 42-mm.-diameter, precision, achromatic objective lens. First-surface-mirror star diagonal for easy viewing. Removable eyepiece. Glare stops in tube. Main tube 38" long. Has a clamp instead of a tripod so that you can attach it to any convenient object to get a sturdier mounting than is possible with a low-cost tripod. ⅜" f.l. eyepiece gives 67X, and a mounted Barlow lens is included, giving about 100X. As lower powers are more satisfactory, accessory eyepieces and lens erecting system for terrestrial viewing are available. Included free are 272-page "Handbook of the Heavens," Star Chart, and 16-page manual.

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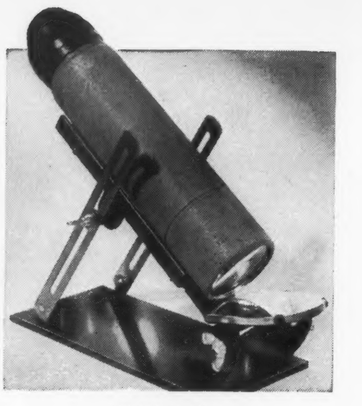
WAR-SURPLUS TELESCOPE EYEPIECE

Mounted Kellner Eyepiece, Type 3. 2 achromats, f.l. 28 mm., eye relief 22 mm. An extension added, O.D. 1¼", standard for most types of telescopes. Gov't. cost $26.50.

Stock #5223-Y......................................$7.95 ppd.



EDSCORP SATELLITE TELESCOPE

OPTICS: The Satellite Scope has two important optical characteristics: A wide (51-mm.) diameter, low-reflection-coated objective lens. A six-element extremely wide-field, coated Erfle eyepiece that, in combination with the objective, gives 5.5 power with a big 12° field and over 7-mm. exit pupil.

OTHER USES FOR THE SATELLITE SCOPE

1. Makes a perfect wide-field finder. A special groove on the barrel helps in locating it in the finder mount. Fits our twin-ring finder mount, Stock No. 70,079-Y—$9.95. 2. Use the Erfle eyepiece on your regular astronomical telescope. You will need our adapter, Stock No. 30,171-Y — $3.95, which gives you an O.D. of 1¼". This eyepiece cost the government $56.00! 3. Makes a wonderful comet seeker; see complete asterisms. 4. Makes a fine rich-field telescope; see wide areas of sky with deep penetration.

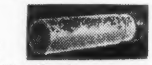
Especially Made for Members of MOONWATCH

Stock #70,074-Y.................................$49.50 ppd.

Now — See the Satellites

NEW, LOW-PRICE "SATELLITER" TELESCOPE

First Time — Only $9.95 ppd.



Get ready for the sky show as more satellites are vaulted into space. Our new, low-price "Satelliter" telescope may also be used to view comets and as a rich-field scope for viewing star clusters. 5 power, wide 12° field, slight distortion at outer edges because of unusual wide field. Use of high-quality war-surplus optics makes possible this bargain. Full 2" achromatic objective — large 9-mm. exit pupil for night use. Scope is 10" long, weighs less than one pound.

Stock #70,150-Y.................................$9.95 ppd.

ROTATING STAR CHART

Planisphere with a rotating chart shows well over 500 stars in the heavens and their relationships to each other at any selected day and hour. Table on reverse side supplies valuable information on constellations, navigation stars, locations of the planets according to month and year, dates of meteor showers, the zodiac, and the like.

Stock #9227-Y...$.50 ppd.

THE METZGER GLARE-REDUCTION SCREEN

The Metzger Glare-Reduction Screen is an accessory to refractors and reflectors, designed to cut planetary glare and help in observing finer planetary detail. The kraft-paper mount affords ample protection to the screen, which should be flat.

Stock #70,138-Y—for 5" O.D. tubes.......$2.95 ppd.
Stock #70,139-Y—for 7" O.D. tubes.......$3.95 ppd.

ASTRONOMICAL TELESCOPE TUBING

Stock No.	I.D.	O.D.	Lgth.	Description	Price
80,038-Y	4⅞"	5¼"	46"	Spiral-wound paper	$2.50
85,008-Y	6⅞"	7⅜"	60"		4.00
85,011-Y	2⅞"	3"	48"	Aluminum	6.00
85,012-Y	3⅞"	4"	60"		8.75
85,013-Y	4⅞"	5"	48"		9.00
85,014-Y	6⅞"	7"	60"		15.00

All tubing is shipped f.o.b. Barrington, N. J.

EDMUND SCIENTIFIC CO.

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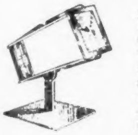
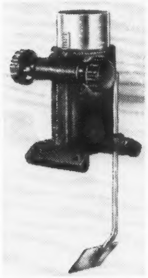
Great Project for Geophysical Year!



A fascinating new field. You can build your own solar furnace for experimentation — many practical uses. It's easy, inexpensive — use your scrap wood. We furnish instruction sheet. This sun-powered furnace will generate terrific heat — 2000° to 3000°. Fuses enamel to metal. Produces many unusual fusing effects. Sets paper aflame in seconds. Use our Fresnel lens — 11¾" diameter, f.l. 14".

Stock #70,130-Y....Package of 1..........$6.00 ppd.
Stock #70,131-Y....Package of 2..........11.00 ppd.
Stock #70,132-Y....Package of 4..........20.00 ppd.

Rack & Pinion Eyepiece Mounts



For Reflectors

For Refractors

Now you can improve performance in a most important part of your telescope — the eyepiece holder. Smooth, trouble-free focusing will help you to get professional performance. Look at all these fine features: real rack-and-pinion focusing with variable tension adjustment; tube accommodates standard 1¼" eyepieces and accessory equipment; lightweight aluminum body casting; focusing tube and rack of chrome-plated brass; body finished in black wrinkle paint. No. 50,077-Y is for reflecting telescopes, has focus travel of over 2", and is made to fit any diameter or type tubing by attaching through small holes in the base. Nos. 50,103-Y and 50,108-Y are for refractors and have focus travel of over 4". Will fit our 2⅞" I.D. and our 3⅞" I.D. aluminum tubes respectively.

Stock #50,077-Y (less diagonal holder)	**$9.95 ppd.**
Stock #60,035-Y (diagonal holder only)	**1.00 ppd.**
Stock #50,103-Y (for 2⅞" I.D. tubing)	**12.95 ppd.**
Stock #50,108-Y (for 3⅞" I.D. tubing)	**13.95 ppd.**

HUYGENS EYEPIECES

Here are some really terrific values in eyepieces! The three eyepieces listed below are manufactured by one of the world's best producers of optical components. We have searched the world's markets, including Germany and France, to find a real quality eyepiece. The image clarity, the workmanship evidenced in the metal parts, will prove the skill and experience of Goto Optical Company, Tokyo. Guaranteed terrific buys!

HUYGENS TYPE — STANDARD 1¼" DIAMETER
6-mm. (¼") Focal Length
Stock #30,063-Y..........................$8.50 ppd.

12.5-mm. (½") Focal Length
Stock #30,064-Y..........................$8.00 ppd.

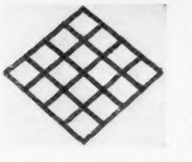
COMBINATION EYEPIECE — 10-mm. and 20-mm.
Stock #30,065-Y..........................$9.00 ppd.

7X FINDER TELESCOPE—ACHROMATIC

Stock #50,080-Y Finder alone, less ring mounts...$9.95
Stock #50,075-Y Ring mounts per pair $3.95

RUBBER PITCH-LAP MAT

Saves Mirror Makers Time and Trouble

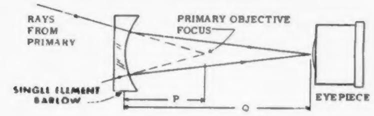


A rubber pitch-lap mat is used for forming the pitch-lap channels. Just pour the melted pitch on the tool, lay the mat on top and then press it in with your mirror to form the channels. When the pitch sets, an easy pull will remove the mat. In minutes instead of hours you are ready to polish. Eliminates time-consuming and tedious hand-cutting of the channels of the pitch lap.

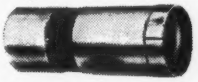
All those disappointing break outs of the pitch, common when hand-cutting the channels, are avoided. You no longer have to pour and cut two or three laps before getting a usable one. With our Rubber Pitch-Lap Mat you can use the first one you make.

Stock No.	Size	For Mirror Dia.	Price ppd.
50,171-Y	**13½" x 13½"**	**8", 10", 12"**	**$2.00**
60,061-Y	**6" x 6"**	**4¼", 6"**	**1.00**

DOUBLE AND TRIPLE YOUR TELESCOPE'S POWER WITH A BARLOW LENS



WHAT IS A BARLOW? A Barlow lens is a negative lens used to increase the power of a telescope without resorting to short focal length eyepieces, and without the need for long, cumbersome telescope tubes. Referring to the diagram above, a Barlow is placed the distance P inside the primary focus of the mirror or objective. The Barlow diverges the beam to a distance Q. This focus is observed with the eyepiece in the usual manner. Thus, a Barlow may be mounted in the same tube that holds the eyepiece, making it very easy to achieve the extra power. The new power of the telescope is not, as you might suppose, due to the extra focal length given the objective by the difference between P and Q. It is defined as the original power of the telescope times the quotient of P divided into Q!



Beautiful chrome mount. We now have our Barlow lens mounted in chrome-plated brass tubing with special spacer rings that enable you to vary easily the power by sliding split rings out one end and placing them in other end. Comes to you ready to use. Just slide our mounted lens into your 1¼" I.D. tubing, then slide your 1¼" O.D. eyepieces into our chrome-plated tubing. Two pieces provided, one for regular focal length eyepieces and one for short focal length ones.

Remember, in addition to doubling and tripling your power, a Barlow lens increases your eye relief and makes using a short focal length eyepiece easier.

Don't fail to try one of these. Many people do not realize the many advantages of a Barlow and the much greater use they can get from their telescopes. Our Barlow has a focal length of −1-5/16". We have received many complimentary letters about this lens. So sure are we that you will like it that we sell it under a 30-day guarantee of satisfaction or your full purchase price returned — no questions asked. You can't lose, so order today.

Stock #30,200-Y Mounted Barlow lens......$8.00 ppd.

OPTICAL IDEA and GADGET CONTESTS

In celebration of International Geophysical Year—

First Contest Ends April 30, 1958
Second Contest Ends Dec. 31, 1958

Our Catalog has full details on rules, prizes and entry blank — Write for Catalog "Y."

PRISM STAR DIAGONAL

For comfortable viewing of the stars near the zenith or high overhead with refracting telescopes using standard size (1¼" O.D.) eyepieces, or you can make an adapter for substandard refractors. Contains an excellent quality aluminized right-angle prism. Tubes are satin chrome-plated brass. Body is black wrinkle cast aluminum. Optical path of the system is about 3½".

Stock #70,077-Y..............................$12.00 ppd.

SPITZ MOONSCOPE

A precision-made 32-power reflecting telescope — by makers of Spitz Jr. Planetarium. Clearly reveals the craters of the moon, shows moons of Jupiter, other wonders of the heavens. Based on same principles as world's giant telescopes. Stands 36" high on removable legs. Adjustable 3" polished and corrected mirror. Fork-type altazimuth mount rotates on full 360° circle — swings to any location in the sky. Fascinating 18-page instruction book; sturdy carrying case.

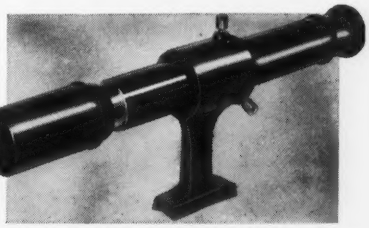
Stock #70,068-Y..............................$14.95 ppd.

"MAKE-YOUR-OWN" 4¼" MIRROR KIT

The same fine mirror as used in our telescopes, polished and aluminized, lenses for eyepieces, and diagonal. No metal parts.

Stock #50,074-Y..............................$16.25 ppd.

6X FINDER TELESCOPE



Has crosshairs for exact locating. You focus by sliding objective mount in and out. Base fits any diameter tube — an important advantage. Has 3 centering screws for aligning with main telescope. 20-mm. diam. objective. Weighs less than ½ pound.

Stock #50,121-Y..............................$8.00 ppd.

MISCELLANEOUS ITEMS

KELLNER EYEPIECE — 2" focal length (1¼" O.D.). Mount of black anodized aluminum.
Stock #30,189-Y..........................$6.00 ppd.

60° SPECTROMETER PRISM — Polished surfaces 18-mm. x 30-mm. — flat to ½ wave length.
Stock #30,143-Y..........................$8.25 ppd.

BRASS TUBING

2 pieces, 3" long, slide fitting. Blackened brass. I.D. 1-3/16", O.D. 1-5/16".
Stock #40,165-Y..........................$1.75 ppd.

30-day Money Back Guarantee as with all our Merchandise!

BE SURE TO GET FREE CATALOG "Y"

Fantastic variety — never before have so many lenses, prisms, optical instruments, and components been offered from one source. Positively the greatest assembly of bargains in all America. Imported! War Surplus! Hundreds of other hard-to-get optical items. Write for Free Catalog "Y."

ORDER BY STOCK NUMBER . . . SEND CHECK OR MONEY ORDER . . . SATISFACTION GUARANTEED!

BARRINGTON • NEW JERSEY

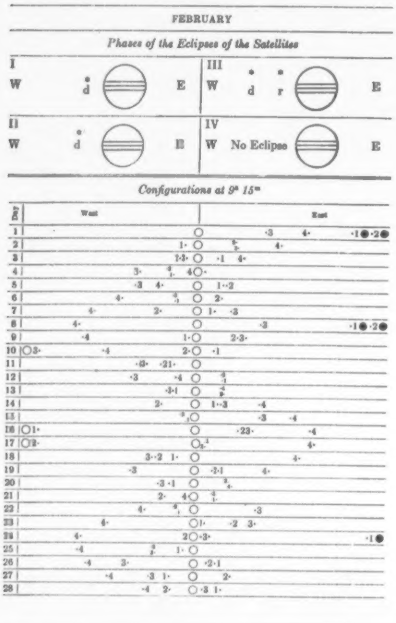
CELESTIAL CALENDAR

Universal time is used unless otherwise noted.

JUPITER'S SATELLITES

The configurations of Jupiter's four bright moons are shown below, as seen in an astronomical or inverting telescope, with north at the bottom and east at the right. In the upper part, *d* is the point of disappearance of the satellite in Jupiter's shadow; *r* is the point of reappearance.

In the lower section, the moons have the positions shown for the Universal time given. The motion of each satellite is from the dot toward the number designating it. Transits over Jupiter's disk are shown by open circles at the left, eclipses and occultations by black disks at the right. The chart is from the *American Ephemeris and Nautical Almanac.*



VARIABLE STAR MAXIMA

February 8, R Aquilae, 190108, 6.3; 17, R Phoenicis, 235150, 7.8; 18, V Monocerotis, 061702, 7.1; 18, R Ursae Majoris, 103769, 7.6; 24, V Cassiopeiae, 230759, 7.9; 25, R Bootis, 143227, 7.3.

March 2, U Ceti, 022813, 7.5; 7, T Centauri, 133633, 6.1; 7, V Coronae Borealis, 154639, 7.4.

These predictions of variable star maxima are by the AAVSO. Only stars are included whose mean maximum magnitudes are brighter than magnitude 8.0. Some, but not all of them, are nearly as bright as maximum two or three weeks before and after the dates for maximum. The data given include, in order, the day of the month near which the maximum should occur, the star name, the star designation number, which gives the rough right ascension (first four figures) and declination (bold face if southern), and the predicted magnitude. Some of the dates have been revised from last month's listing.

MINOR PLANET PREDICTIONS

Astraea, 5, 8.9. January 27, 8:20.3 +16-33. February 6, 8:11.7 +17-40; 16, 8:04.9 +18-40.

Ceres, 1, 7.1. January 27, 7:33.0 +31-43. February 6, 7:24.4 +32-16; 16, 7:18.3 +32-33; 26, 7:15.3 +32-36. March 8, 7:16.6 +32-28; 18, 7:19.0 +32-12; 28, 7:25.3 +31-48.

Davida, 511, 9.2. January 27, 10:13.4 +24-12. February 6, 10:06.5 +25-46; 16, 9:58.7 +27-12; 26, 9:50.9 +28-20. March 8, 9:44.0 +29-08; 18, 9:38.9 +29-35.

Harmonia, 40, 9.4. January 27, 9:53.6 +18-01. February 6, 9:44.0 +19-11; 16, 9:33.6 +20-16; 26, 9:23.7 +21-09. March 8, 9:15.8 +21-43.

Metis, 9, 8.7. January 27, 10:51.3 +16-59. February 6, 10:44.5 +18-08; 16, 10:35.6 +19-18; 26, 10:25.5 +20-17. March 8, 10:15.9 +21-00; 18, 10:08.1 +21-19.

Kalliope, 22, 9.9. February 6, 11:10.4 +27-17; 16, 11:03.0 +28-28; 26, 10:54.3 +29-26. March 8, 10:45.3 +30-03; 18, 10:37.0 +30-17; 28, 10:30.2 +30-06.

After the asteroid's name are its number and the magnitude expected at opposition. At 10-day intervals are given its right ascension and declination (1950.0) for 0^h Universal time. In each case the motion of the asteroid is retrograde. Data are supplied by the IAU Minor Planet Center at the University of Cincinnati Observatory.

MOON PHASES AND DISTANCE

Full moon	February 4, 8:05
Last quarter	February 10, 23:34
New moon	February 18, 15:38
First quarter	February 26, 20:51
Full moon	March 5, 18:28

	February	Distance	Diameter
Perigee	5, 23^h	224,200 mi.	33′ 07″
Apogee	21, 15^h	252,300 mi.	29′ 26″
	March		
Perigee	6, 9^h	222,100 mi.	33′ 26″

MINIMA OF ALGOL

February 2, 4:16; 5, 1:05; 7, 21:55; 10, 18:44; 13, 15:33; 16, 12:22; 19, 9:12; 22, 6:01; 25, 2:50; 27, 23:40. March 2, 20:29; 5, 17:18; 8, 14:08; 11, 10:57.

These minima predictions for Algol are based on the formula in the 1953 *International Supplement* of the Krakow Observatory. The times given are geocentric; they can be compared directly with observed times of least brightness.

OCCULTATION PREDICTIONS

February 2-3 **Lambda Geminorum** 3.6, 7:15.7 +16-37.1, 14. Im: **I** 12:27.4 +0.1 −1.6 109.

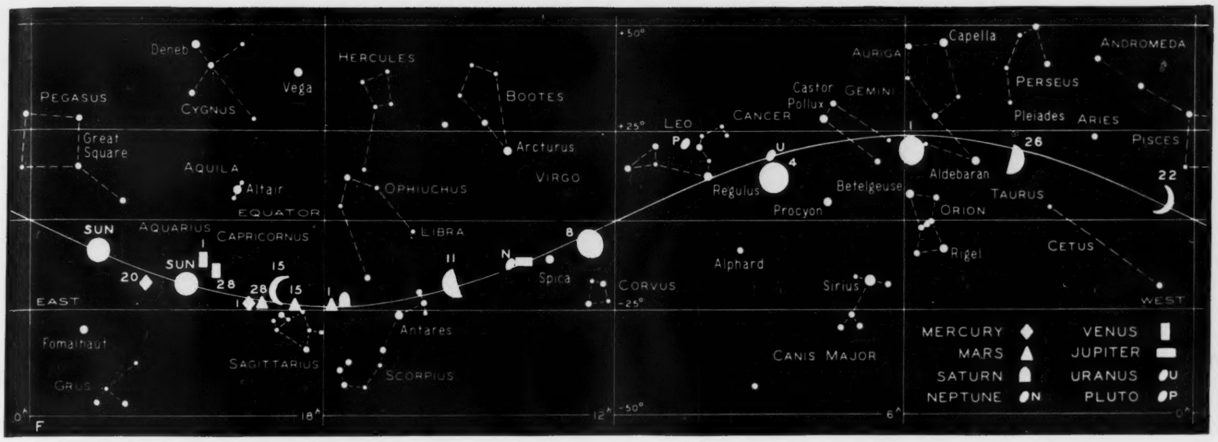
February 10-11 **Alpha Librae** 2.9, 14:48.6 −15-52.1, 22. Im: **C** 10:02.5 −3.0 +1.9 54; **D** 10:07.3 ... ... 38; **E** 9:29.5 −2.0 +1.4 74; **F** 9:10.9 −1.3 +0.2 110. Em: **C** 10:50.7 −1.1 −2.7 343; **D** 10:34.6 ... ... 358; **E** 10:32.6 −1.2 −1.2 327; **F** 10:28.7 −1.8 −0.3 294; **H** 9:59.0 −1.0 +0.8 278.

For stations in the United States and Canada, usually for stars of magnitude 5.0 or brighter, data from the *American Ephemeris* and the *British Nautical Almanac* are given here, as follows: evening-morning date, star name, magnitude, right ascension in hours and minutes, declination in degrees and minutes, moon's age in days, immersion or emersion; standard-station designation, UT, **a** and **b** quantities in minutes, position angle on the moon's limb; the same data for each standard station westward.

The **a** and **b** quantities tabulated in each case are variations of standard-station predicted times per degree of longitude and of latitude, respectively, enabling computation of fairly accurate times for one's local station (long. **Lo**, lat. **L**) within 200 or 300 miles of a standard station (long. **LoS**, lat. **LS**). Multiply **a** by the difference in longitude (**Lo−LoS**), and multiply **b** by the difference in latitude (**L−LS**), with due regard to arithmetic signs, and add both results to (or subtract from, as the case may be) the standard-station predicted time to obtain time at the local station. Then convert the Universal time to your standard time.

Longitudes and latitudes of standard stations are:

A	+72°.5,	+42°.5	**E**	+91°.0,	+40°.0
B	+73°.6,	+45°.5	**F**	+98°.0,	+31°.0
C	+77°.1,	+38°.9	**G**	Discontinued	
D	+79°.4,	+43°.7	**H**	+120°.0,	+36°.0
			I	+123°.1,	+49°.5



THE SUN, MOON, AND PLANETS THIS MONTH

The sun, on the ecliptic, is shown for the beginning and end of the month. The moon's symbols give its phase roughly, with the date marked alongside. Each planet is located for the middle of the month or for other dates shown. All positions are for 0^h Universal time on the respective dates.

Mercury is a morning object, but too close to the sun to be seen this month.

Venus rises about three-quarters of an hour before the sun on February 1st, and is visible low in the east-southeast. By midmonth it will be a prominent object of magnitude -4.1, coming up about $1\frac{1}{2}$ hours before sunrise. In the telescope the planet will appear as a 10-per-cent illuminated crescent with a diameter of 54″.

Mars is in Sagittarius in midmonth, rising about $2\frac{1}{2}$ hours before the sun. Its magnitude at that time is $+1.5$. The disk has a diameter of less than 5″, making Mars a very poor object for telescopic observation this month.

Jupiter on the 15th is in eastern Virgo, rising about an hour before midnight, local time. Retrograde motion begins on the 16th, when the planet's magnitude is -1.8 and the disk has an equatorial diameter of 40″. On February 9th, at 13:45 UT, the moon will pass 1° 40′ south of Jupiter, as seen from the earth's center.

Saturn is a morning star in Ophiuchus, and rises about $3\frac{1}{2}$ hours before the sun in midmonth. Its magnitude is $+0.8$. On the 13th there is a conjunction with the moon, Saturn being 2° 29′ south at 8:59 UT, as seen from the center of the earth.

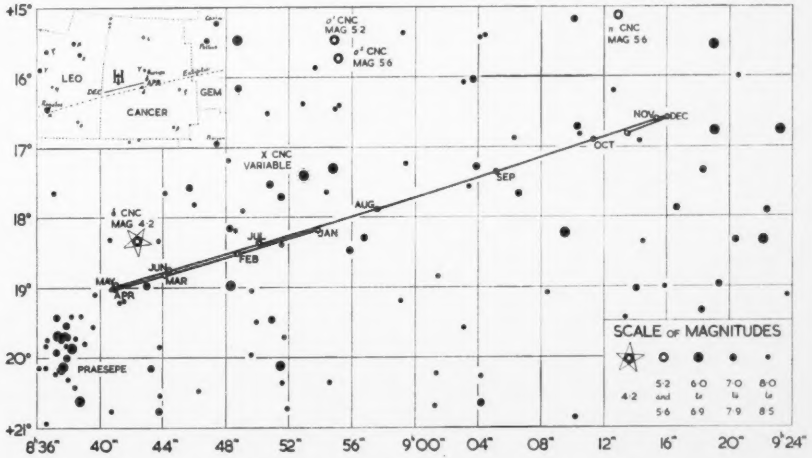
Uranus is a 6th-magnitude object in Cancer, and crosses the meridian about 11 p.m., local time, on the 15th. It is visible most of the night. The planet's path for 1958 is shown on this page.

Neptune is in eastern Virgo, as shown by the accompanying chart; on February 15th it crosses the meridian at 4:33 a.m., local time. On the 5th this 8th-magnitude planet will be stationary in right ascension and begins its very slow retrograde motion.

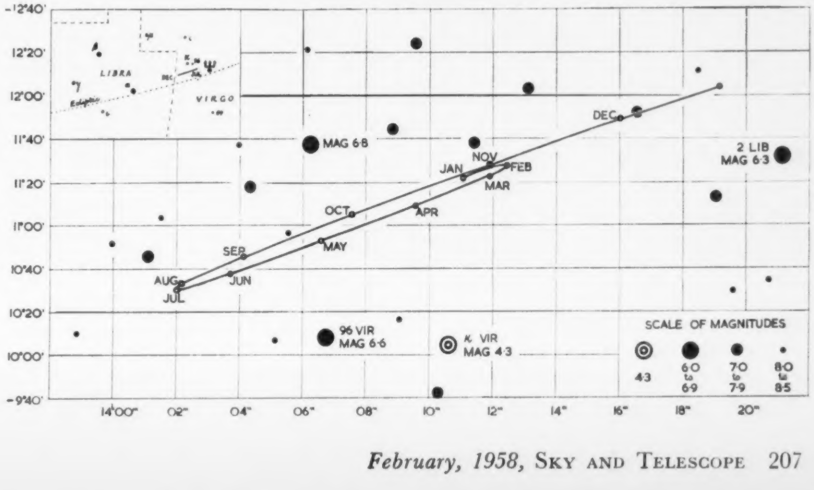
Pluto comes to opposition with the sun on February 20th, at which time it is 3.1 billion miles from the earth. Of the 15th magnitude, Pluto is located in Leo, at right ascension 10^h $30^m.1$, declination $+22°$ 10′ (1950 co-ordinates) on the 20th.

Artificial satellite observations in evening twilight may be made with the aid of a star chart from a January issue of *Sky and Telescope;* for morning observations use a July chart. Observers far north or south may need a chart from an earlier or later issue.

W. H. G.

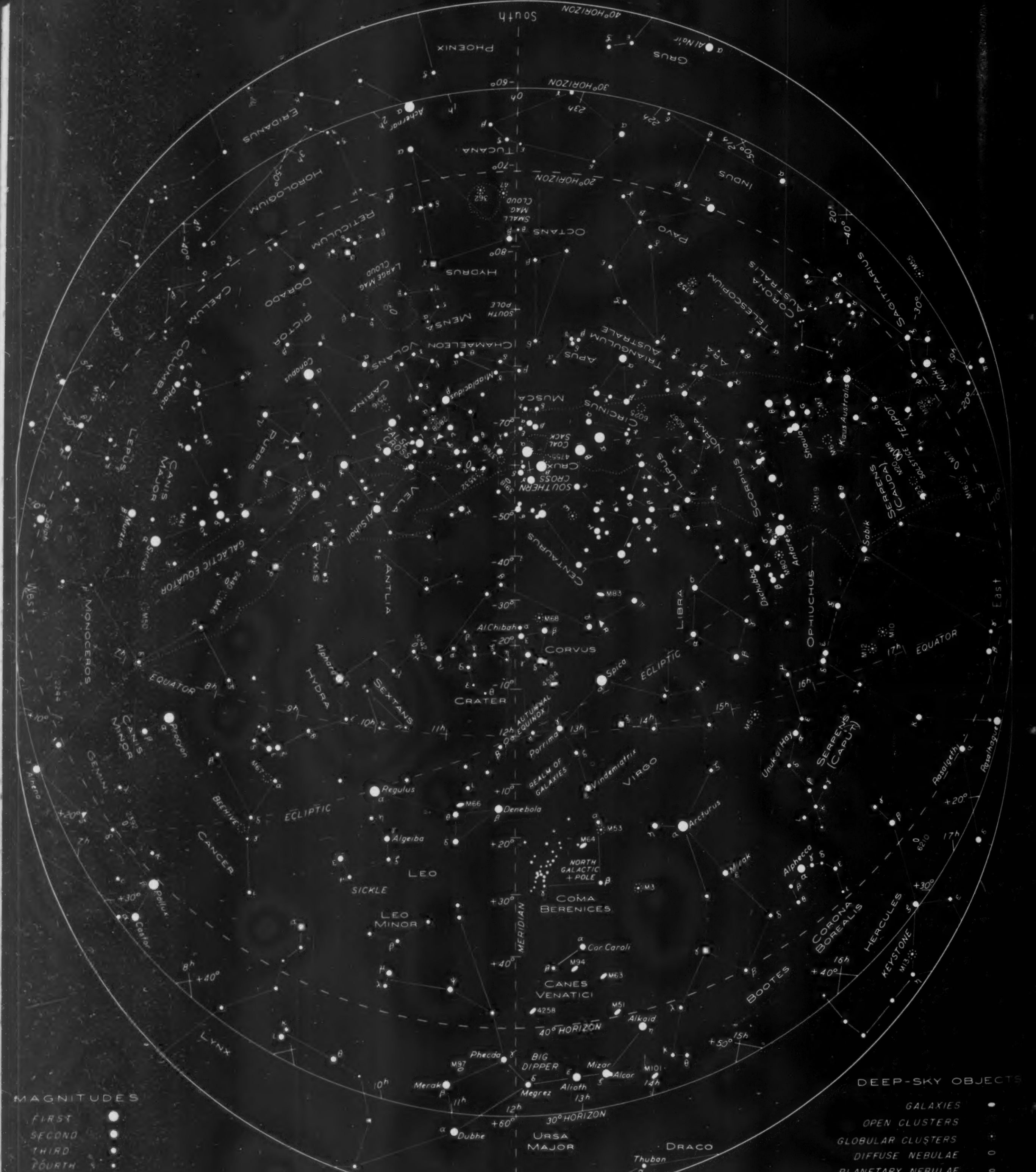


The path of Uranus among the stars of Cancer is shown above; that for Neptune among the stars in Virgo, below. In each case the field is inverted, with south at the top, as seen in an astronomical telescope. (The insets have north at the top.) The scales of the two charts are not the same. From the 1958 "Handbook" of the British Astronomical Association.



UNIVERSAL TIME (UT)

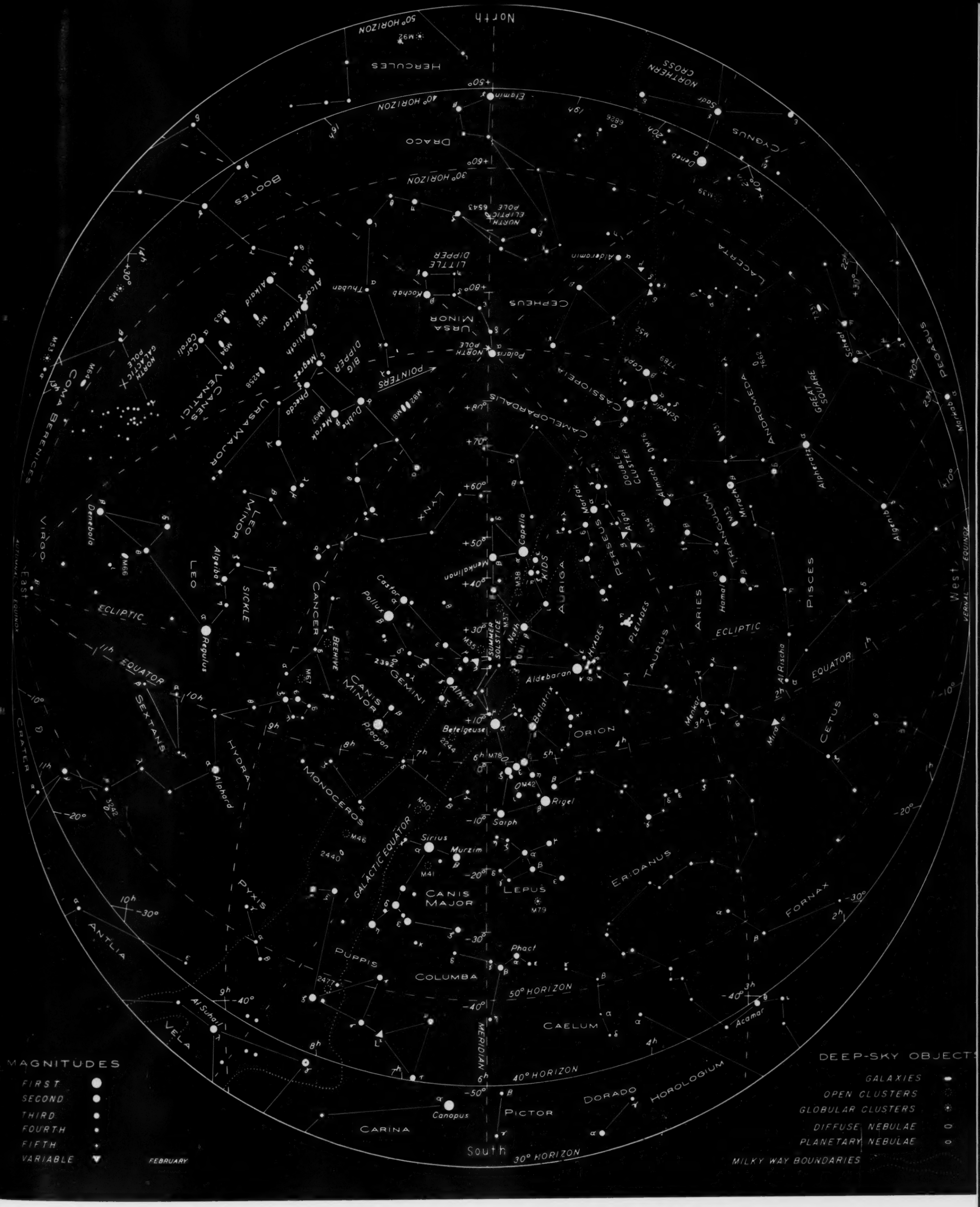
TIMES used in Celestial Calendar are Greenwich civil or Universal time, unless otherwise noted. This is 24-hour time, from midnight to midnight; times greater than 12:00 are p.m. Subtract the following hours to convert to standard times in the United States: EST, 5; CST, 6; MST, 7; PST, 8. If necessary, add 24 hours to the UT before subtracting, in which case the result is your standard time on the day preceding the Greenwich date shown.



SOUTHERN STARS

The sky as seen from latitudes 20° to 40° south, at 11 p.m. and 10 p.m., local time, on the 7th and 23rd of April; also at 9 p.m. and 8 p.m. on May 7th and 23rd. For other dates, add or subtract ½ hour per week.

The three horizon circles on both the northern and southern star charts make the maps usable over a wide range of latitudes, and also aid when the observer is visualizing the form of a constellation that is only partly above the horizon at a particular time.



STARS FOR FEBRUARY

The sky as seen from latitudes 30° to 50° north, at 9 p.m. and 8 p.m., local time, on the 5th and 21st of February, respectively; also, at 7 p.m. and 6 p.m. on March 7th and 23rd. For other dates, add or subtract ½ hour per week.

When facing north, hold "North" at the bottom; turn the chart accordingly for other directions. The equator, ecliptic, galactic equator, and meridian are dashed curves, as are the hour circles that are three and six hours east and west of the meridian.